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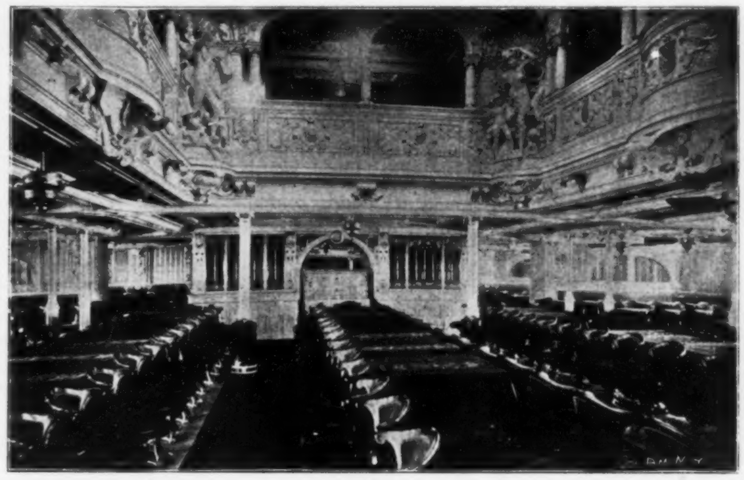
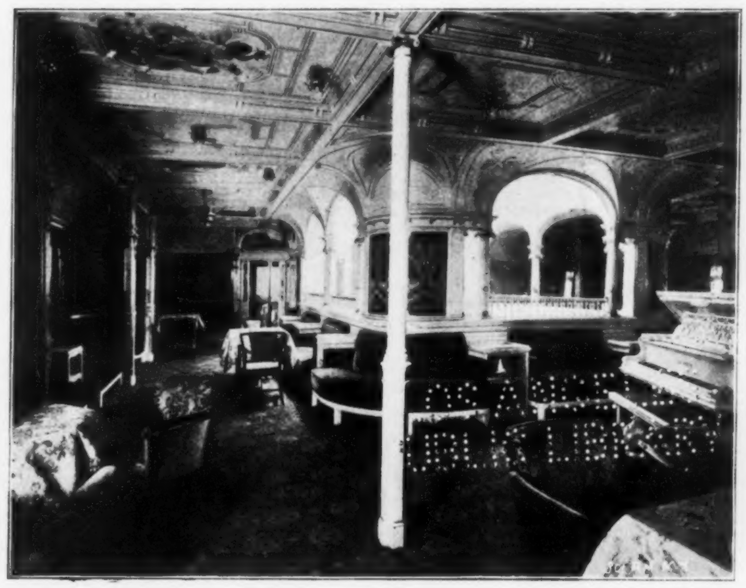
PROMENADE DECK; 508 FEET STRAIGHT PROMENADE.



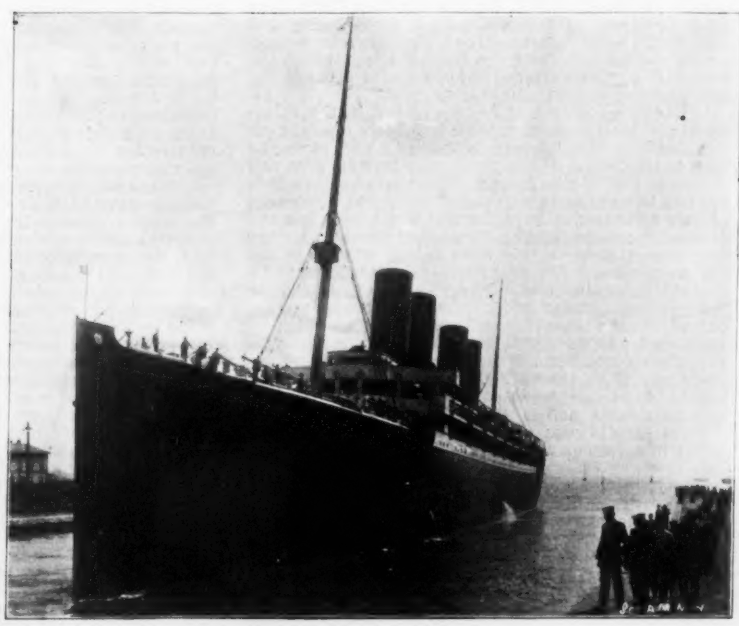
THE DINING SALOON; 414 SEATS.

LIBRARY AND READING ROOM.



DRAWING ROOM.

ENTRANCE TO SMOKING ROOM.



THE "KRONPRINZ WILHELM."

THE "KRONPRINZ WILHELM," WHICH CONVEYED PRINCE HENRY TO AMERICA FOR THE LAUNCHING OF THE 'METEOR.'

THE "KRONPRINZ WILHELM."

The "Kronprinz Wilhelm" possesses particular interest just now for the dual reason that she is the latest exponent of the art of building high-speed Atlantic mail steamers, and that she was selected to carry Prince Henry and his suite to this country to attend the christening of the Kaiser's new American-built yacht. The "Kronprinz" is the natural descendant of a line of truly magnificent express steamships which, because of certain distinguishing characteristics, may be said to have their progenitor in the "Kaiser Wilhelm der Grosse." The "Kaiser Wilhelm" came into line as a record-breaker at the point at which that splendid pair of ships "Campania" and "Lucania" had placed the record, namely, at an average speed for the whole trip of just over 22 knots an hour. She was an epoch-making vessel in more than one respect. To begin with, she was the first German ship to hold the transatlantic record. Then again, she was the first steamship of the largest size to be built in a German yard, and of German materials, and although her horse power was officially announced at 28,000, it has been well understood that at times, when the fuel has been good quality and the stokers have been diligent, the horse power has risen to as high as 31,000 to 32,000. She had not been long on the route before she had brought down the average speed for the whole trip to 22½ knots an hour, and when she was fully two years old she surprised everyone by making the trip at an average speed of over 22⅔ knots an hour.

Following the "Kaiser Wilhelm" came the "Deutschland," probably the most successful, all-round vessel ever produced for the Atlantic mail service. She broke the record on her maiden run, and in her first season, during a trip on which the writer had the good fortune to be a passenger, she covered the distance between Sandy Hook and the Lizard at an average speed of 23 1-3 knots an hour. Although this vessel was guaranteed by contract to develop only 33,000 horse power, she has actually developed as high as 38,000; indeed, the average for the whole trip just referred to was slightly under 37,000 horse power, while the consumption of coal averaged 572 tons per day. This looks like a very heavy coal bill, and yet, when we consider the horse power developed, it is a highly economical one; for if we exclude the auxilaries, which consumed 30 tons per day, the consumption was only 1 1-3 pounds of coal per horse power per hour for the main engines. This in itself was at the time a record performance for the marine engine, and it was attributed by the engineers of the vessel to the admirable efficiency of the Howden system of forced draft. Last year the "Deutschland" showed a further increase of speed, averaging for one whole trip to the eastward 23.5 knots an hour. The "Kaiser Wilhelm" is 649 feet long and her displacement is 20,000 tons. The "Deutschland" is 686 feet long and has a displacement of 23,000 tons. Before passing on to a description of the "Kronprinz Wilhelm," our readers will be interested to know that the two German companies, the Hamburg-American, owners of the "Deutschland," and the North German Lloyd, under whose flag the "Kaiser Wilhelm" sails, hold entirely divergent views on the very important subject of furnace draft. The North German Lloyd ships using natural draft only, while the Hamburg-American vessels are fitted with forced draft.

The "Kronprinz Wilhelm" was put into service by the North German Lloyd Company in the latter part of the season of 1901. In size she comes midway between the "Kaiser Wilhelm" and the "Deutschland." She is 663 feet 4 inches in length, and her displacement is 21,280 tons; her engines according to the contract were to develop 33,000 horse power; but in spite of the fact that the boilers are fired under natural draft, she has already indicated over 37,000 horse power, and at times she has steamed for several hours together at the rate of 23.8 knots an hour. Her best average for an eastern trip is a fraction over 23 knots an hour; but it is fully expected that during the coming season she will equal, if she does not surpass, the record of the "Deutschland," which stands, as we have said, at an average of 23.5 knots an hour from Sandy Hook to the Lizard. The coal consumption of the "Kronprinz Wilhelm" is about 560 tons in twenty-four hours. The engines are of the six-cylinder, tandem, quadruple-expansion type, and the boilers, which are of the standard Scotch type, are arranged in four groups, in each of which there are three double and one single-ended boilers. The ship has four smokestacks, the tops of which are 113 feet above the grates. The total heating surface is 94,000 square feet and the total grate area 2,691 square feet.

In the arrangement of her decks and in the superstructure, the "Kronprinz Wilhelm" bears a strong resemblance to the "Kaiser Wilhelm." The forecastle deck is 115 feet in length, the bridge deck 374 feet, and the poop 115 feet in length. The promenade deck is 508 feet in length and provides an unbroken promenade of over 1,000 feet. Above the promenade deck is a sun deck of the same length. The vessel provides for 600 first-class passengers, 350 second-class passengers and 700 third-class. The crew, under which term is included the engine and boiler room staff, deckhands, waiters, etc., numbers 525. The accommodations are finished on the same rich scale of decoration which obtains on the "Kaiser Wilhelm;" but with the difference that the color scheme is more subdued and, therefore, more restful to the eye. The dining room is in the center of the ship, between the forward and after pair of smokestacks, and is a superb room, with accommodations for 414 passengers at one sitting.

Our illustrations give an excellent idea of the variety and richness of the decorations, furnishings and upholstery. It is expected that before the close of the summer season of 1902 a larger edition of the "Kronprinz Wilhelm" will be placed upon the route of the North German Lloyd Company. The "Kaiser Wilhelm II.," as she will be called, is to be the longest ship in the world and the fastest; for although her contract does not call for it, she will be the first vessel to reach the 24-knot an hour mark.

According to the French Journal Officiel the production of cork in the world, estimated at 1,000 tons, is limited to those regions whose shores are washed by the Mediterranean and the Atlantic, extending from Morocco up to 45 deg. north latitude, nearly to Bordeaux. The only producing countries, therefore, are Portugal, Spain, France, Italy and North Africa (Tunis, Algeria and Morocco). It is impossible to determine, even approximately, the total extent of the forests of cork trees owing to the lack of any precise information. But it is known that the forests in question cover an area of about 1,482,000 acres in Portugal, 741,000 acres in Spain, 197,600 acres in Italy, and France, with her North African possessions, 1,632,670 acres. But it may be said that the area of French forests, including those in North Africa, really producing cork is more than one-half of the total extent of cork forests. These forests are composed mainly of cork trees intermixed with pines and evergreen oaks; in the eastern Kroumirie, however, magnificent forests of çork trees are to be found in their virgin state which will in the future give a large production of cork. It is said that France, the United Kingdom, Germany, Russia and the United States absorb 85 per cent of the total consumption of cork. Germany and the United States of America impose prohibitive duties on cork manufacturers, but admit the raw material free. The United Kingdom alone imposes no customs duty on either. Her consumption of the manufactured article is provided for by French and Spanish manufacture, and by Portugal, from which country the United Kingdom imported in 1900 manufactured cork to the amount of $29,580,085. Spain exports principally the finished product.

OUR COAL SUPREMACY AND ITS SIGNIFICANCE.

By Edwin Money, D. C. L., LL.D.

Next to the character and spirit of a people, there are no factors which equal in importance an abundant, sure and cheap supply of food and fuel. While this is true of every age it is pre-eminently true of the present, which is primarily an industrial, commercial age. And it is upon this broad and sure foundation that the superstructure of American commercial supremacy is building—a supremacy the ever-increasing importance of which is just beginning to be fully realized; and which is destined to exert a tremendous influence upon the civilization and upon the politics of the world. As is natural, a realization of this fact has led to jealousies on the part of other nations so that we are called a nation of shop keepers; and other epithets which are not usually considered as terms of endearment are not wanting in the vocabulary of the nations of Europe when America is the topic of conversation. But, on the other hand, self-interest which ever has been, and to all appearances ever will be a vital force in determining political action, dictates a policy of friendship toward us.

The importance of our position as the granary of Europe has for a long time been recognized. In speaking of this a century and a quarter ago, Burke gives utterance to one of the most beautiful sentences in all literature: "The scarcity which you have felt would have been a desolating famine if this child of your old age with a true filial piety, with a Roman charity, had not put the full breast of its youthful exuberance to the mouth of the exhausted parent." It is, however, only recently that our supremacy as regards coal supply has attracted general attention. So that when but yesterday the Paris, Lyons and Mediterranean Railway purchased 75,000 tons of American coal it is not surprising that it should have awakened comment. While a cheap food supply has always been, and will of necessity ever continue to be, an important factor in production, it is nevertheless true that with the industrial revolution of the last few decades the importance of coal has increased relatively as well as absolutely. Invention after invention has made it more and more certain that the role which machinery will play in production must be an ever-increasing one. The evident corollary to which is that coal, which furnishes the motive force by which machinery is run, will continue to subtend a larger and larger arc in the circle of economic production, which is simply another way of saying that the nation having the largest and cheapest coal supply can, other things being equal, dictate the economic policy of the world. This has been foreseen by economists for some time. Jevons, the great English economist, writing upon the "Coal Question" in the sixties, uses the following language: "Day by day it becomes more obvious that the coal we happily possess in excellent quality and abundance is the mainspring of modern material civilization. As fuel, or the source of fire, it is the source at once of mechanical motion and of chemical change. Accordingly, it is the chief agent in almost every improvement or discovery in the arts, and as the source especially of steam and iron, coal is all powerful. This age has been called the Iron Age, and it is true that iron is the material of most great novelties. By its strength, endurance and wide range of qualities, it is fitted to be the fulcrum and lever of great works, while steam is the motive power. But coal alone can command in sufficient abundance either the iron or the steam, and coal, therefore, commands this age—the Age of Coal. Coal, in truth, stands not only beside, but entirely above, all other commodities. It is the material energy of the country—the universal aid—the factor in everything we do. With coal, almost any feat is possible or easy; without it, we are thrown back into the laborious poverty of early times." While this language is no doubt somewhat extreme, it forms the basis of a prophecy—the transfer of the industrial and commercial supremacy from Great Britain to the United States—the realization of which we have lived to see.

Not only the change in the methods of manufacture, but also the change in the means of transportation has served to emphasize the relation between a nation's coal supply and its progress. The cost of railroads and of steamships is measurably in proportion to the price of iron and steel, which in turn is evidently dependent upon the price of coal; and what is true of the materials of construction is still more evident as to the motive force (steam) which propels the trains and the steamships. While the United Kingdom mined more coal than the United States and Germany combined—and this was the fact as late as 1881—it is not so strange that she was the workshop of the world, and with scarce a competitor in the carrying trade. But ever since 1870 the United States has gained upon the United Kingdom until in 1898, for the first time, we surpassed her in our output of coal. What this means no one realizes better than does Great Britain herself, as can be seen from the press of that country.

The area of our coal fields at present opened to mining is more than five times as great as that of the coal fields of Western Europe. And while practically all the available coal area of the United Kingdom, Germany, France and Belgium—the great coal producing countries of Europe—has been opened to mining, we have scarcely begun. Upon the output of coal by the leading coal producing countries the following table, taken from a report by the United States Bureau of Statistics for April, 1900, upon the World's Coal Supply and Trade, is both interesting and instructive:

Year.	U. S. Tons.	Great Britain. Tons.	France. Tons.	Germany. Tons.
1870...	36,806,560	123,682,935	37,488,312	14,530,716
1875...	52,288,320	149,303,263	52,703,970	18,694,916
1880...	71,481,569	164,605,738	65,177,634	21,346,124
1885...	110,957,522	178,473,588	81,227,255	21,510,359
1890...	157,770,963	203,408,003	98,398,500	28,756,638
1895...	193,117,530	212,320,725	114,561,318	30,877,922
1898...	219,974,667	226,301,058	144,283,196	35,748,641

In 1840 our entire output of coal was probably less than 2,000,000 tons, and according to none of the estimates did it exceed 3,000,000. By 1860 it had risen to 16,573,123 tons, by 1880 to 71,481,569, and by 1900 to 245,422,000 tons. In the last named year the United Kingdom produced 225,181,000. Thus, since 1868, the output of the United States has increased 700 per cent while the output of the United Kingdom has increased a little less than 100 per cent; but worse than this, the production of the United Kingdom has declined for the last three years and that of Germany and France is at a standstill, while during the same period the United States has increased its production by over 45,000,000 tons, or nearly 25 per cent. If we go back to 1840, the earliest date for which reliable estimates can be had, we find that during the past sixty years our output has increased by more than 10,000 per cent. While in 1840 the production was less than one-sixth of a ton per capita, in 1900 it was between three and four tons per capita. Nor have we yet reached a point which is anywhere near our limit; it is estimated by a writer in the Engineering and Mining Journal of recent date that with its *present* plant, the United States could turn out from three to four times the present amount. While the 15,800 square miles of coal area of the United Kingdom, Germany, France, Belgium and Spain have practically all been laid under contribution, we have scarcely touched one-fourth of our 194,000 square miles of coal area. Nor is it merely coal area, and hence in potential resources, that we outclass Europe, but in other respects, which, for the present at least, are of more importance. These we will now consider.

As the greater part of my life has been spent in the coal fields of Pennsylvania, I have had opportunities, not only of observing the mining operations of those regions, but also of conversing with miners from all parts of Europe with reference to the advantages and disadvantages connected with the mining of coal in the old world and the new. The conditions under which coal is mined in this country and in Europe vary widely, and these conditions are important factors in determining the cost. In Europe most of the veins lying near the surface are worked out, so that deep mining is now the rule rather than the exception. In the United States we have not as yet been, and for years will not be forced to face the problem of deep mining. In many of our mines the coal is brought from where it is mined to the tipple by gravity, and a mine of this sort is known as a drift. A drift may be horizontal or inclined upward from the opening. Drifts are practically things of the past in the United Kingdom and Western Europe. A slope is the term used to describe a working where the vein inclines downward from the opening—in this sort of mine the coal is drawn up the inclines to the pit's mouth by mules, steam power, or electrical power. The old method of transportation by mules has been displaced in American mines by steam and electrical power. A shaft, which is the term applied to the remaining class of mines, is constructed where it is necessary to go down perpendicularly through the earth and rock until the vein to be worked has been reached; the coal is then brought to the foot of the shaft and hoisted to the surface by steam or electrical power. Other things being equal, mining operations are more expensive where it is necessary to operate by means of a shaft, which is the case in the majority of European mines, and the expensiveness increases with the depth of the mines. For there is not only the increased cost of constructing the shaft, but the increased time and power necessary to bring the coal to the surface, and the increased cost of pumping and ventilating, which in some cases is very considerable. Furthermore, where the mine is very deep, as is the case in some European mines, it becomes necessary to replace the wooden with steel props, whereby the expensiveness of mining is further increased. Nor is this all, for in very deep mines the temperature, which increases one degree for every 62.1 feet in depth, is such as to render labor less effective. As to the relative depths of mines in Europe and America, the following facts taken from reports are of sufficient interest to warrant quoting them:

Great Britain.	Feet.
Pendleton Colliery	3,474
Dolcoath mine	2,400
Harris Navigation	2,100
Ashton Moss	2,880
France.	**Feet.**
Gagmeres	2,640
Societe Cockerill	1,730
Germany.	**Feet.**
Rhein Elbe	3,300
Oelsnitz	3,100
Belgium.	**Feet.**
Hennete	3,772
St Gilly	3,280

With but one or two exceptions these depths are for the last decade. They are of course extreme depths,

but in the United States 400 to 600 feet are considered extreme.

Another condition affecting very materially the cost of production is that most American mines are new, while the majority of the European mines are old. This is important for two reasons: First, because the new shafts are more scientifically constructed and have better equipment and, second, the distance from the place where the coal is being mined to the foot of the shaft (or the mouth of the drift or slope, as the case may be) is greater in the older mines, and as underground transportation is expensive, this consideration is an important factor in determining the cost of mining operations, not infrequently necessitating the construction of a new shaft. The thickness of the vein is also of particular importance as a factor in determining the cost of coal production. In this also we have an immense advantage over Great Britain and over Europe generally. The average thickness of coal veins in the United Kingdom is perhaps not over three feet, and those of the Continent are still thinner, while the bulk of our coal is taken from veins averaging nine feet; and if we take our entire coal area, which as we have seen is over ten times that of the United Kingdom and Western Europe, our average will still be over five feet.

The introduction of labor-saving machinery has been much more rapid in American than in European mines. In the last decade the number of coal-cutting machines in use in the soft coal districts of the United States has increased over 600 per cent, and when we consider that this alone reduces the cost of mining by from fifteen to forty cents a ton, its importance is evident. I have dwelt upon these conditions at considerable length in order that we may appreciate the fact that notwithstanding the higher wages paid in the United States, we can produce coal at nearly half the price at which it can be produced in Europe. The following table I take from the British Government report for 1899. The figures represent the price per ton at the pit's mouth:

France	10s
Belgium	9s 11d.
Germany	7s 9d.
United Kingdom	7s 7d.
United States	4s 8½d.

In Cassier's Engineering Magagine for 1901 the estimates of the price per ton at the tipple in Alabama, Maryland and West Virginia are 95, 85 and 65 cents respectively, and this it is stated can readily be reduced by from 5 to 20 per cent. Our supremacy is still more evident when we remember that the price of coal in Europe is increasing, while in the United States it is decreasing, as is shown from the following statistics taken principally from O. P. Austin's report for April, 1900. Average value at the pits' mouth:

	United Kingdom.	Germany.	France.	Belgium.	United States.
1896	5s 10 1/4d	6s 11d	8s 8 1/4d	7s 7 1/4d	4s 9 1/4d
1897	5s 11d	7s 1 1/4d	8s 8 1/2d	8s 2 1/2d	4s 7 1/2d
1898	....	7s 4 1/2d	...	....	4s 5 1/2d
1899	7s 7d	7s 9d	9s 12d	9s 11d	4s 4 1/2d

If we compare the quantities produced per person employed in the United Kingdom and in the United States we find that whereas the quantity is decreasing in the former it is increasing in the latter. Here are the figures taken from the highest authority:

United Kingdom.	United States.
1883—347 tons.	1883—not given.
1889—326 tons	1889—421 tons.
1897—297 tons	1897—450 tons.
	1898—489 tons.

In view of all these facts which point in the same direction, viz., the supremacy of the United States in coal production, it is but natural to expect that our coal exports would increase—and such is the fact. Our exports of coal have more than trebled in the last decade. For the fiscal year 1891 they were 2,339,039 tons, while for the fiscal year 1901 they were 7,676,148 tons. They have doubled in value since 1897 and more than doubled in quantity. In December, 1900, contracts were made for 900,000 tons of American soft coal to be delivered during the present year to Russian and French ports alone. We are now third in the list of coal exporting nations, being exceeded only by the United Kingdom and Germany. Our railroads carrying coal to tidewater have improved their road beds and put on heavier engines; also cars of a larger capacity and more durable material, so that the freight rates from the Pennsylvania, West Virginia and Maryland fields have fallen considerably. It is stated by good authorities that with a line of steamers of our own, constructed especially for the purpose, being of great carrying capacity and of about ten knots speed (which is, all things considered, the most economical) coal could be shipped from tidewater to the British ports for 5s. per ton and to the ports of Southern Europe for 6s. 6d., whereas we are now paying 12 to 14s. per ton. When these conditions are realized—and in all probability the day is not far distant when they will be; and viewed in connection with the fact of increased cost of coal production in Europe—it is neither wild nor chimerical to predict that we will very soon practically control the coal markets of Europe. Europe herself feels this. The London Trade Journal admits "that the American exports of coal in the future may acquire as much importance as have American exports of cereals and cotton." The London Statist, for March, 1900, says: "The best American coal can be delivered at Mediterranean ports at a price lower by six or eight shillings per ton than Cardiff coal, which is of about the same quality." The same authority says that in nearly all European countries there is a scarcity of coal, due partly to an approaching exhaustion of deposits which can be mined cheaply. A British writer, Bennett Brough, says: "Throughout Europe consumers are complaining of the difficulty of obtaining an adequate supply of coal. This scarcity of coal is a matter of vital importance. British industrial supremacy has been largely due to the abundant supplies of coal at reasonable prices. With a coal famine and exorbitant prices, the manufacturing power of the country will disappear. Great Britain, however, is not suffering alone, for coal is equally scarce in Germany, France, Belgium, Austria and Russia."

As an evidence of how the tables have been turned, I would cite the fact that but recently European vessels trading in American ports brought over enough coal to meet partially their requirements for the home voyage; now they take on enough coal in America to carry them to Europe and back.

The fact that we can undersell Europeans in their own market is important not merely as indicating that our exports will increase rapidly, but vastly more significant as being unmistakable evidence that we have a more abundant and cheaper supply than they as the basis for our manufactures and transportation. The exporting of coal to other nations may not be an advantage to us, but the possession of a better supply unquestionably is. While the taxing of exports of coal is now a practical question for Europe, and is being seriously considered, it will for years remain an academic question with us. That our exports will for some time to come increase rapidly; that this will be of temporary advantage in relieving the pressure caused by a surplus in the home markets; that it will encourage American companies to build large colliers and thereby make us a more important factor in the carrying-trade of the world, is reasonably sure. But the immense and permanent advantage which our vast supply will be to us as a manufacturing and commercial nation does not admit of question. The conclusions forced upon us by this survey may be stated as follows: Coal is the material monarch of the industrial kingdom, the center of which he has caused to be transferred from Albion's hills to Columbia's valleys, whence future dynasties will rule the economic world by natural right.

University of Wisconsin.

THE FLIGHT OF A HAILSTONE.

By Arthur H. Bell.

A hailstone, when dissected, is found to be an aggregate of tiny crystals disposed in concentric rings or zones; zones which, if rightly cross-examined, will have much to tell concerning the wonderful journey of the hailstone as it plunged through the atmosphere on its way to the earth. A snowflake makes this same journey through the air in a more leisurely fashion, and it does not arrive at its destination with the noise and rattle that announces the descent on the earth of hailstones; but the two travelers are very nearly related, for they are both the offspring of aqueous vapor. It is part of the work of the meteorologist nowadays to discover, if he can, why the moisture in the air sometimes takes the form of a snowflake, while at others it crystallizes as a hailstone. To merely record the size of a hailstone is insufficient, for these frozen pellets of moisture have more interesting attributes.

At the heart of every hailstone is a tiny atom of dust, which may be considered to be the very foundation of the whole icy structure. These atoms of dust pervade every part of the atmosphere. Not only are they found in the lower strata of the air, but the winds carry them far above the highest mountains, and no matter whether samples of air obtained by balloonists or by mountain travelers are examined, minute particles of dust are always everywhere to be found. Indeed, it is becoming understood that without an atom of dust upon which the moisture of the air could settle there would be no rain-drops, no snow, no fog, dew, clouds or hail. Without these minute platforms, as they may be called, upon which the moisture as it condenses could alight, rain would be continually pouring down upon the earth, and it is these motes that keep the moisture buoyed up in the atmosphere until such times as circumstances compel them to yield up the aqueous supplies which they so industriously collect. Supposing, then, that a little vapor should happen to condense on a particle of dust floating aimlessly through the air, there is a beginning made of what, under favorable conditions, may ultimately grow to a full-sized hailstone.

It is highly probable that, for a hailstone to have fitting opportunity of growing to maturity, it must take its plunge to the earth from a great height. The clouds which float at the greatest distance from the earth are those known as the cirrus, which are often seen many miles above the tops of the highest mountains. If, then, an incipient hailstone can only dive toward the earth from this dizzy height it will in its headlong flight pass through strata of air differing very much as regards moisture and temperature, and these are the circumstances most favorable to its development.

But before the growing hailstone can launch itself downward it must by some means or other contrive to get itself carried up to these serene and chilly heights. Briefly, it makes the journey by stepping, as it were, into one of the strong ascensional currents of air which spring upward from almost every part of the earth's surface. These currents are revealed by the cumulus clouds which are but the visible tops of columns of air. As these rising currents of air rush upward they presently arrive at a height where the air is rare and cold, so that the aqueous vapor they carry with them condenses and promptly assumes the form of a cloud; a process that may be likened to a rocket which bursts into a visible cloud of fire at the end of its upward flight. If, then, the dusty atom with its tiny load of moisture that is subsequently to form the nucleus of a hailstone can succeed in entering such a rising stream of air, it will ere long find itself at a height that will ultimately prove to be an admirable coign of advantage. In this position it resembles nothing so much as an oak apple dancing at the top of a jet of water, for in each case an ascending current keeps the object buoyed up.

But it often happens that yet loftier heights are necessary for the growth of a hailstone. Supposing, then, that a further upward flight is desirable, there is a convenient motive force ready to hand. It is well known that whenever condensation of moisture takes place latent heat is set free, so that when the aqueous vapor is actively engaged, say, in condensing into the form of a cloud, it is probable that great supplies of warmth spring into being. This warmth, of course, raises the temperature of the air, and as the latter becomes warmed it rises and another form of ascending current is thereby produced. Such a current provides the hailstone with a means of conveyance to those exalted regions it is so advantageous to reach. Probably at the end of its long journey the incipient hailstone will be far up in one of the cirrus clouds, surrounded by particles of moisture frozen by the cold rarefied air into ice crystals, so that in its new situation the hailstone would find ample supplies of the material so necessary for its growth.

In such company it is not long before the moisture on the atom of dust also freezes. The form which the frozen moisture will take depends on circumstances, but there are many possibilities before it. Thus it may crystallize as a tiny pellet of snow, or it may take the shape of an ice crystal, or it may commence as a snowflake; while in certain circumstances it will simply take the form of a frozen rain-drop. Any of these shapes will serve as an excellent starting point from which to commence the earthward journey.

During all the time of its upward journey the force of gravitation has been steadily pulling at the rising atom of dust and its load of moisture. Few things floating in the air can long resist this imperative call to return to the earth.

Falling slowly downward, the motion being slow at first because the bulk of frozen moisture is small, the hailstone at once commences to attract to itself other particles of frozen moisture. These adhere to it much in the same way that snow-flakes will adhere to anyone traveling quickly through a snow storm; so that as the hailstone pushes its way downward it grows in bulk. Moreover, as its weight increases it may happen that its center of gravity shifts, and it becomes accordingly of an irregular shape. This accident indeed accounts for many of the curious shapes assumed by hailstones and gives them that peg-top shape which is so often observed. It is to be remembered also that a hailstone takes a long time to drop from the clouds to the earth, it being calculated that the journey may often occupy ten minutes. In this interval most of the transformations occur that produce the full-grown hailstone.

Imagining now the journey to be well started it will at once be realized that the traveling hailstone will pass through strata of air that differ very much as regards temperature and moisture. Some of the air will be above the freezing point and other layers will be below it; while it will be no uncommon episode for the dropping hailstone to plunge sheer through a cloud that may be thousands of feet thick. The hailstone itself, with its heart of ice, is always below the freezing point, so that any moisture that settles on it is promptly frozen and forms a girdle of ice around the central nucleus. An examination indeed of any hailstone shows that these icy girdles are its most characteristic feature. It will also be observed that these girdles or zones are of two kinds, and that they are alternately clear and opaque. It is these zones that tell the most concerning the incidents of a wonderful journey, for they are produced by the different strata of air through which the hailstone passed, each country, as it were, over which the journey was made impressing its characteristics on the flying traveler.

When the hailstone passed through air that was below the freezing point the moisture that settled upon it was frozen in the form of a clear zone of ice; while, on the other hand, when the air and its contained moisture were above the freezing point the girdle of ice was opaque.

A further important consideration as regards the hailstone is that moisture may often be reduced in temperature below the freezing point without actually congealing. It is a common experiment thus to treat moisture, but it is always found that the slightest agitation of this cooled liquid at once causes it to crystallize. When, therefore, the hailstones come pelting through air in this condition it will readily be understood that the commotion produces a plentiful supply of ice crystals, many of which are quickly annexed by the hailstones, which are thereby greatly increased in size.

The foregoing are the most common conditions that favor the growth of a hailstone, and it will be concluded that the essential conditions required are layers of air of different temperatures. Now it frequently happens that hail accompanies a thunderstorm or a tornado; these two phenomena being very nearly related. In both there is an atmospheric whirl, which, in the tornado, produces a strong wind that is commonly of a destructive character. If, then, a hailstone should be going through its evolutions in the neighborhood of one of these storms it stands a good chance of being whirled round and round in the air, a process that may continue for a considerable time. This violent treatment, however, has the same effect as if the hailstone were falling downward through the air, and the result is that it may be carried again and again through first a cold stratum of air and then through a warm one. As already seen these are the very conditions that favor the growth of hailstones, and hence it is that hail so commonly accompanies thunderstorms, tornadoes, and such like atmospheric disturbances.

The whirling of hailstones through the air cannot, however, continue indefinitely, for presently they grow so heavy that they fall in a rattling stream from the edge of the cloud. Observation shows that hail showers often pass across the country in parallel lines; but it will be gathered that this is owing, as described above, to the fact that stones are ejected from the sides of the storm cloud and not so much from its center. Hailstorms, as a rule, are not of a very large area, and are much longer than they are wide. The width is regulated by the dimensions of the cloud, the length being governed by the distance to which the internal energy of the storm urges the storm-cloud forward.

Hail occurs more frequently during the day than in the night, and in summer than in winter. It also falls more copiously over the land than over the sea, where it is but rarely observed. Hail, indeed, is a turbulent child, and it does best in those localities and at those seasons when the atmosphere is in a variable mood. At such times the cross currents in the air produce those eddies which are the most favorable for the growth of storm-clouds, out of which leap

the tornado and the thunderstorm. Plains also are more often visited by hail than mountainous regions, for here again the atmosphere is more likely to be in an unstable condition because such exposed ground often varies greatly in its temperature. Hail, moreover, is rarely met with in the Arctic regions, thunderstorms being equally rare in this locality. It is this circumstance, among others, that has caused some people to give atmospheric electricity a prominent position in relation to hail formation, and more especially so because lightning and hailstorms frequently occur together. Caution, however, is always necessary when putting electricity forward as a cause, for to do so is often to explain one mystery by another. From what has been said it will be gathered that there are simpler explanations of the flight of a hailstone, and it is along these more obvious lines that the history of this interesting phenomenon is nowadays being studied.—Knowledge.

NURSERIES FOR GRAPEVINE GRAFTS.

By R. SPOERR.

SANDY soil is best adapted for the establishment of a nursery of the culture varieties of grapevines. But not all sandy soils are equally good. Dark sandy soil, rich with humus, is better than white sandy soil. Limey and clayey soils are least adapted. Other soils, such as clay, marl and gravel, are absolutely worthless for nursery purposes on a large scale. In heavy soils, the graftings cannot receive as good attention as is possible in sandy soils. The latter can be more readily worked and do not crust as heavily; they are also more rapidly warmed by the sun and permit a better circulation of air than does heavy soil. Especially when the heavy soil is in a cold position it is altogether useless.

A level, exposed position, with light sandy soil, gives best results. Since sandy soil is most readily worked, the costs of labor are least, which is a factor to be considered. Sandy soil also admits of a more beautiful and more luxuriant root formation. In dry and sticky soils, the graftings grow poorly. Trees in the neighborhood of the nursery are undesirable, since the shading of vegetation ruins the growth of the grafts.

Paths are first marked out, separating the territory into blocks. When a large number of grapes is to be grown, it is best to make these blocks long in order to avoid short rows; the shorter the rows, the more land is wasted for pathways and the more labor is wasted, since the beginnings and endings of rows require more time, and short rows of course present more beginnings and endings than long rows. Rows of a large nursery may be 40 to 100 meters (44 to 109 yards, about) in length. Divide the section into squares or rectangles in the following way:

Decide upon your main path and place pegs, by means of the cross or theodolite. After the walks have been thus marked out, dig them out to the depth of 15 to 35 centimeters (5 to 8 inches), and distribute the earth on the blocks laid out. Where the land slopes, the ways will serve as drains. In such cases it is best to examine closely into the direction of the slope, in order to allow for heavy downpours of rain and to grade the depth of the walks accordingly. If this is neglected, the first heavy rain will break through the earth prisms and cause great damage by washouts and by tearing out the graftings. If the ground in which the nursery work is to be done has never before been used, it will have to be cultivated. It is sufficient to set the cultivator to a depth of 40 centimeters. The luxuriant development of roots depends on the looseness of the soil, and since it is in the interest of the grower to produce finely-rooted plants, the labor and expense of cultivation should not be avoided. A fine setting of roots pays. Cultivation should be followed by a heavy application of stable manure. Use a harrow to break up clods and follow it with the hoe. It is best to make these preparations in the fall and winter, but the final work of the hoe should be reserved till spring, since the soil hibernates better under the clod.

As soon as the soil is sufficiently warmed through, nursery work can begin. The sooner the vines are placed in their trenches, the greater a period of vegetation will there be, and consequently the stronger the vines. Difference in luxuriance of vegetation clearly distinguishes plants that are started early from those that are started late, especially in heavy soils. The nursery work should all be done during the months of April, May and the beginning of June.

FIG. 1.—GRAFTS AFTER UNCOVERING WHEN ROWS ARE SUFFICIENTLY FAR APART.

The actual beginning of nursery work depends on the weather and on the position of the land. If the land has a warm exposure and is composed of readily warmed sandy soil, the planting can begin earlier than if the location be cold or the soil loam.

The nursing of the grafts is one of the most important operations in this process and requires greater attention than is usually given to it.

For the purpose of production in large quantities, the one method most commonly used is that of Richter. It has been tried with eminent success for a number of years, and has entirely displaced the old method of cultivation by the harrow alone. The Richter method involves a larger amount of heat in the soil, and a greater aeration, which facilitates root formation to an unusual extent. Finally, the Richter method has the advantage that when the plot is watered through the summer, the water can reach the graft directly, and that when the grafts are to be dug and the graft roots to be removed, this process is very much facilitated.

FIG. 2.—GRAFTS AFTER UNCOVERING WHEN ROWS ARE NOT SUFFICIENTLY FAR APART.

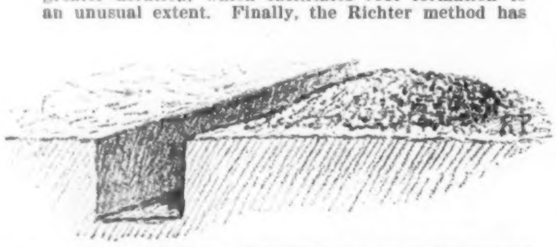


FIG. 3.—DIFFERENT PHASES OF THE NURSING OF GRAFTS ACCORDING TO RICHTER.

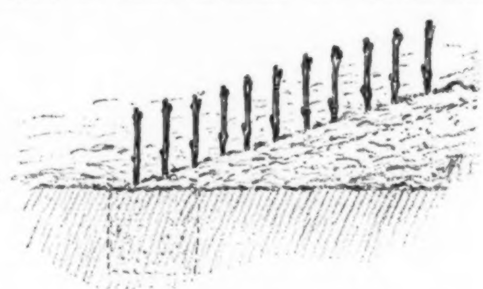


FIG. 5.—GRAFTS WITH TRENCH CLOSED.

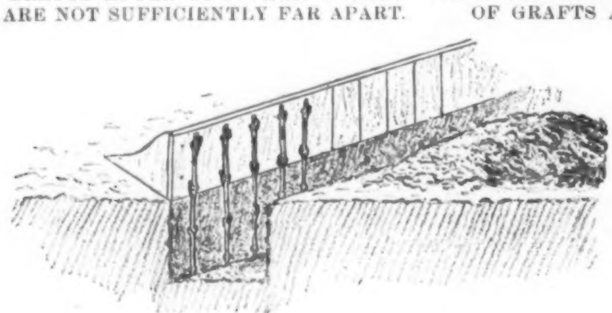


FIG. 4.—SETTING THE GRAFTS.

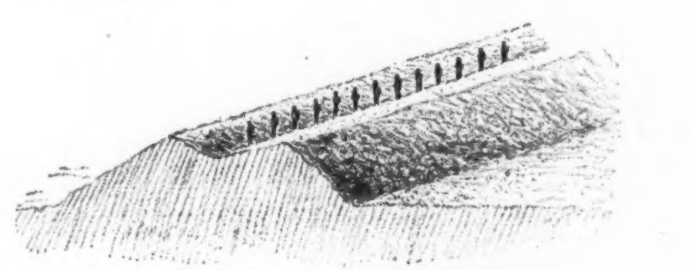


FIG. 6.—GRAFTS AFTER THE FIRST HILLING.

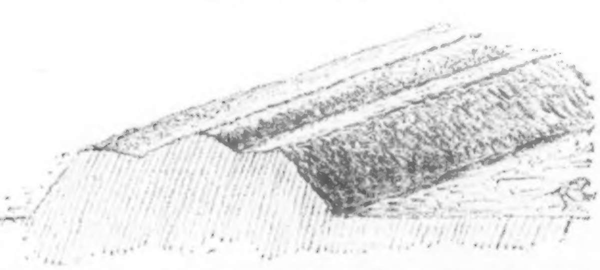


FIG. 7.—GRAFTS COVERED WITH FINE EARTH BY HAND.

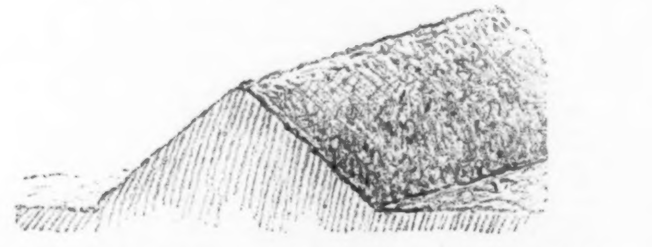


FIG. 8.—THE COMPLETED PRISM AFTER THE SECOND HILLING.

The only disadvantage connected with the Richter method in contrast to the old method is that the Richter method requires more space. But this slight disadvantage is balanced by the great advantages which this method presents. Of course it will only furnish good results if properly used.

The errors which are frequently made are these:

1. An effort is made to save space; this has three disadvantages. One is that when the rows are too close together there is not sufficient earth to form the ridge and many of the grafts can thus not be completely covered. The second disadvantage is that there is not sufficient room left between the rows for walking purposes, which is detrimental to the work of the summer. The third disadvantage is that in the leveling of the ridges later on, there is not room between the rows for the earth and it rolls back.

2. Frequently the graft is laid too low or too high. When too low, the ridge above it will of course be too high. Nutrition would be wasted before the graft has reached sufficient size to break through the high earth ridge. And since the scion cannot continue growth after this expenditure of force unless it reaches the air to assimilate further nutriment, it will perish. It is apparent that such coarse blunders in the nursery work make the success of all of it doubtful. If the slip is placed too high, the graft will either be covered too little or not at all with earth. This fault can be discovered by the fact that the tips of the vine will appear above the top of the ridge. All vines not sufficiently covered with earth will be dried up by the influence of the air.

It must be borne in mind therefore to place all grafts which are to be covered with the same height of earth at an equal depth. A ridge of three or four centimeters above the slips is sufficient to prevent desiccation. In dry soil it can be raised a trifle higher. The nursery work begins with the determination of the direction of the rows. The best direction is from east to west, since this position involves the warming of the ridge evenly on both sides during the day. If the rows are placed north and south, then, of course, the east side will be warmed in the morning and the west side in the afternoon. When a piece of land is used several successive years, care is taken to locate the ridges of one year where the depressions of the previous year were. This constant change results in complete utilization of all the nutritive principles of the soil. The distance between ridges should be between 100 and 120 centimeters; the distance between plants in the row, from 5 to 10 centimeters. After the direction and interval has been determined, the first row is traced and dug. The trenches need not be very wide, and the narrower the shovel or spade which is used, the more quickly will the work proceed. The depth of the trench is 25 centimeters, since all of the slips are 50 centimeters long, 25 centimeters of which will project out of the ditch. The grafts are not slanted, but placed perfectly upright; the more perpendicularly a vine is placed, the stronger the development of roots at the foot. This strength of root is desirable. The more a vine is slanted, the heavier the development of side roots. An upright position develops side roots in a feeble way. After the grafts have been set, a man follows the worker and waters the grafts. Two watering pots, without perforated tops (roses), are to be used. There are two watering pots used because it is easier to carry two than one, and when the rows are long, frequent trips to the water supply are avoided if two cans are used. If there is no well or creek in the neighborhood of the nursery field, it is necessary to place a large tank there and cart the water with a wagon. The fertilizer best adapted is thoroughly decayed stable manure or a mixture of artificial fertilizers. Counselor Professor Doctor Julius Nessler recommends the following artificial fertilizer for vine nurseries: 100 kilogrammes ground oil cake, 100 kilogrammes of Thomas meal (nitrogenous substance), 50 kilogrammes of kainite.

When it is necessary to establish the nursery in heavy soil, because no other soil is available, a decided

improvement of the soil can be made by the addition of several wagon loads of sand. But in order to avoid the carting of too much sand, it is best to limit the use of sand to the trench and to each hill.

Besides the usual Richter method of nursery establishment a combination is sometimes used. It consists in having two rows of the grafts covered by one common earth prism.

FIG. 9.—GRAFT NURSING IN HEAVY SOIL COVERED WITH SAND.

This saves considerable space, but is rather difficult to handle during the work of the summer.

It does not matter what variety is to be trained; each variety should have its own nursery number. If an entire section consists of one variety, the entire section is labeled with one shingle. If several varieties are to be grafted, it is frequently the case that one row contains several kinds. At the beginning of each kind a shingle is placed which bears the nursery number, and this is put in place immediately when the grafts are placed into the trench. An index is kept of these nursery numbers, giving the date when this variety was first placed in the trench, on what stock it was inserted, and how many graftings of it had been made.

Latterly a plow has been constructed in France to be used in this sort of nursery work. According to the statement of the inventor, this apparatus furnishes good and cheap labor. The plow consists of the threefold scarificator, which loosens the soil. This is followed by a pronged cylinder, intended to break up the clods and still further reduce the soil. Then comes a chisel-shaped plowshare, which digs the trench; the laborer places the grafts into this ditch. The grafts are in a basket fastened on the plow. There is also a seat for the man on the plow. Furthermore, there is a water-tank with a sprinkling pipe, which waters the grafts after they are in place. Behind the water-pipe there are two plowshares which close the trench. In order to keep the plow in measured motion, it is not hitched directly to the horses, but moved by means of a windlass. With this plow, 20,000 grafts can be planted in a ten-hour day; a result decidedly inexpensive. If this plow can really do what is claimed, it will find a permanent place in our large vine nurseries, and will displace manual labor in them as surely as sowing machines have displaced manual labor in ordinary agriculture.

The work of spading can be done either by hand or with a team. When done by hand, the depth of the spade will be sufficient. Since this work requires no particular skill, the overseer can be relieved of it by placing it in the hands of laborers. Of course the work can be done much more cheaply with a team. It is necessary to use a cultivator with three or five small blades, which can be set for a working distance of 40 to 50 centimeters. Since the horse cannot pass readily between the hills, this cultivator is moved by means of a wire rope, running over a spindle at the end of the hills, while the horse runs the length of the side. The diameter of the rope should be four or five millimeters.

The loosening of the top soil and the process of weeding should be undertaken as often as necessary. If the earth on the prism has been strongly crusted by long rains, the top of the prism must be loosened on the ends and the sides with a flat hoe. If this be neglected, the feeble green sprouts of culture vines cannot break through and appear. And if the incrustation is allowed to remain until the reserved substances of the culturing process have been used up and the sprout has not had an opportunity of breaking through, the graft will die.

Weeds are removed at the same time as the earth is loosened, since they would otherwise shade the grafts and deprive them of nourishment.

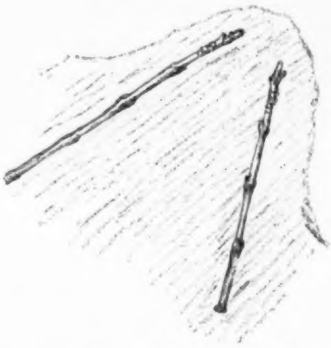


FIG. 10.—COMBINED RICHTER METHOD.

The important work of removing the roots from the grafted vines has to be undertaken two or three times during the summer, as it may be found necessary. During a cold, wet spring, the ingraftation proceeds slowly, but at the same time a luxurious formation of roots takes place. The opposite is true in a dry warm spring. Since the rootings of the graft suffice for the sustenance of the graft, the stock becomes useless, and since the latter can form no sprout of its own (for its eyes—buds—have been cut out) it dies. The formation of roots on the culture vine is detrimental to that of

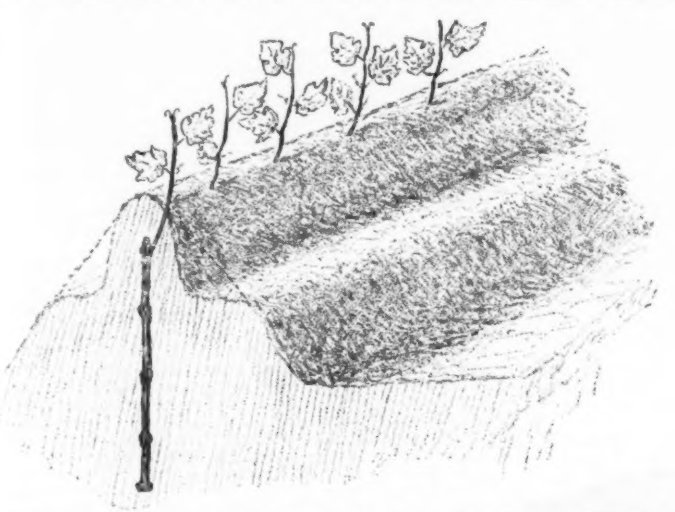


FIG. 12.—THE SOIL HAS BEEN DRAWN OFF FROM EITHER SIDE OF THE GRAFTS WITH THE HOE.

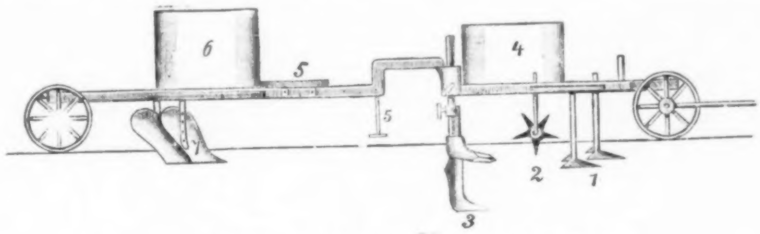


FIG. 11.—PLOW FOR PLANTING SLIPS OR GRAFTS.

1. Subsoil plows. 2. Colters. 3. Chisel-shaped share. 4. Basket containing grafts. 5. Seat for operator and foot-rests. 6. Water tank. 7. Two plowshares.

FIG. 13.—CLOSED WATER DITCH.

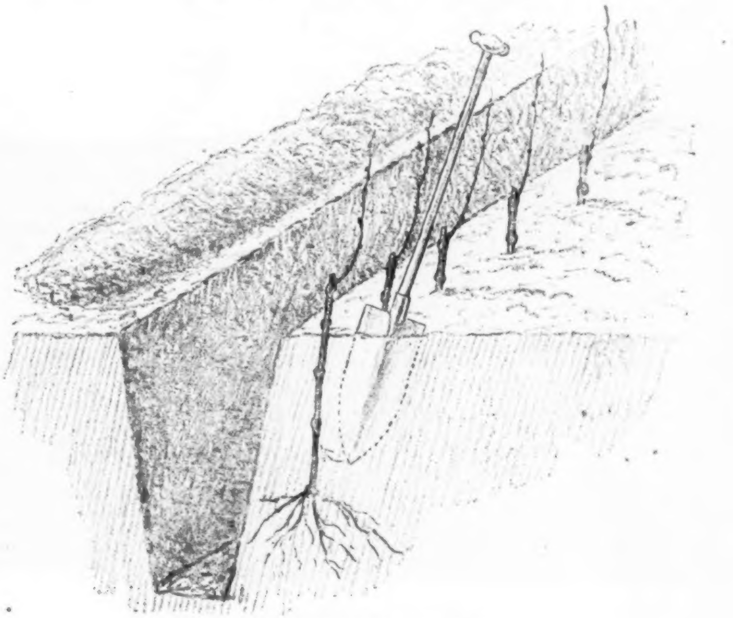


FIG. 14.—DIGGING GRAFTS.

FIG. 15.—STACKED GRAFTS.

a. Against the wall in single rows. *b.* In double rows in the open.

roots on the stock. If the roots on the culture are allowed to develop, unhindered, the culture becomes entirely free and goes back in value to its original stock. When the culture scion is nourished by its own roots, the stock discontinues the formation of callus and hence ingraftment is destroyed. Tests are to be made at different places to see whether the cultures are developing strong roots. If this is the case, the work of removing these roots should begin.

This work may be called "revision." The first revision is to be undertaken when the culture has grown several centimeters above the earth.

The process of vegetation in those varieties of culture vines which are made on such stock as roots with difficulty, as, for instance, Solonis or Berlandieri, is peculiar. Since the growing process in these slow-rooting varieties is different, the root cleaning process of the cultures is also different. When a Berlandieri stock is to be cultured, the formation of graft tissue at the joint begins first. Afterward the culture starts to form roots, while a feeble ring of callus begins to form at the lower end of the stock. During this time the culture breaks through the soil and is nourished by its own roots. It now becomes necessary to investigate carefully by removal of the earth whether the Berlandieri stock is beginning to form small roots. When this has come about, the removal of the roots from the culture becomes necessary, and the first revision is undertaken then. By this means the culture is compelled to draw its mineral sustenance from the soil through the roots of the stock. The stock, on the other hand, receives the organic sustenance which has been assimilated by the culture by reflex action. This co-operative process of stock and culture brings about an intimate engraftment. For the fact that the sprout of the culture amply nourishes the stock gives the small roots of the latter an opportunity to be strongly developed. The difficult point of the operation is to bring about the formation of the beginnings of the small roots. Once formulated, they soon grow.

The proper period for cleaning the roots must not be overlooked, and it is necessary to examine closely and frequently whether the Berlandieri stock is beginning to root. Any neglect in this respect gives the scion roots opportunity to develop very strongly. And if a large growth of roots is removed at any one time, the smaller roots of the stock are not able to afford sufficient nourishment for the strongly developed culture. The result is that both stock and culture die. If the culture takes places on rotted vines of Berlandieri, this extraordinary method is not required, since the roots are able to nourish the grafts from the very first.

August or September is the month for the last revision and total uncovering of the prism. This uncovering must be done in successive stages and not at once; otherwise the white section of the sprout, which is under ground, is dried up by too sudden exposure to the rays of the sun. It is best to take small sections of earth at intervals of a few days, so that the white sprout becomes accustomed to the sun.

When cork grafting is used, this is removed when the prism has been uncovered; it is no longer essential to the graft and hinders the development of strong and large joints. Pry off the wire around the cork with pinchers, but leave the cork on for another week. Then take off the corks and gather them into baskets, because they can be used again.

Watering the grafts produces luxuriant vegetation. The prism itself should not be watered, since that would further the formation of roots on the culture. It is a fact easily demonstrated that moisture and heat favor the formation of roots. Water also assists in the liquefaction of the nutriment in the soil. If fertilization has been neglected in the fall or during the planting of the grafts, it can be given at the same time with the water. An artificial fertilizer readily soluble in water is strewn between the rows and water sprinkled over it. If a natural fertilizer is used, it may be dissolved in water. Toward the end of the summer, no more watering is done, so that the process of vegetation may not be protracted and thereby the complete ripening of the green sprouts be delayed.

In large vine nurseries, the digging is done in the fall, so that there may be time through winter and spring to pack and ship the vines. If the attempt were made to dig in the spring, the frozen earth would hinder such digging for too long a period, and leave too little time for shipping the vines. Digging must not be begun until the largest part of the leaves have dropped. If it is done before this, the natural substances contained in the leaves fail of returning to the plant. Culture grafts dug before the final fall of the leaves lose the reservoir of food substances which they will otherwise have. Premature digging also has the disadvantage that the leaves will have to be taken off, which is considerable work. If they are not taken off, they act somewhat like a prematurely harvested moist hay and heat about the graft—a heat which can be sensed by the hand and is sufficient to desiccate the entire graft in some cases. The beginning or middle of November in most cases is the best time for digging.

At a distance of five centimeters from the row of culture-grafts a trench is dug, the earth being thrown out on the side opposite the row. The trench must be deeper than the root end of the grafts. On the side opposite the trench a small spade is inserted with each graft and the graft dislodged into the trench by lateral pressure. It is necessary to have the best workmen for this work. And it is unprofitable to hurry the workmen, since the grafts are readily broken or the roots torn off. Great stress must be laid upon the proper preservation of the roots. If any of the roots are torn off, a graft does not represent first-class and faultless material. It will be seen that the work of digging decreases the percentage of utilizable grafts.

Sorting of the culture grafts can be undertaken right on the growing spot, if the weather is favorable. Otherwise it should be done under cover. It is necessary to have the proper "feel" in sorting, otherwise a number of sales may be spoilt and considerable difficulty experienced. The honest manager of the nursery for culture vines must make his principal motto to have "careful sorting." The regular dealer cannot afford to store his cultures in the open, since frosts will interfere with his business at times. The vines will have to be kept and earthed under cover. For this purpose it is best to use sand. Soil cannot be used readily. The sand so used can be profitably mixed with coarse powdered charcoal, which has an antiseptic action and prevents the rotting of the roots.

The grafts are well covered with sand up to the sprout. The sand is to be moderately moist; if it is too wet the roots rot; if it is not wet enough the roots dry up. Subject to the moisture or dryness of the inclosed store room, it will be necessary to moisten the sand every eight to fourteen days. The grafts should not be stacked too high, otherwise those at the bottom will become dry. Grafts can be stacked horizontally or upright. Upright stacking is not advisable where a large number of vines are to be kept in covered places, since it requires more room. Horizontal stacking is preferable. The grafts can be stacked either along the walls in one row, or in the center of the building in double rows. The rows should be at most one and a half meters high. If the stack is against the wall, the root end should be against the wall. Let sand be put between the wall and the roots. When a double stack is made, turn root ends in. The first layer should not be put on the ground, but on a stratum of sand ten centimeters high. Different sorts can be separated by lath or boards.

For our engravings and the accompanying details we are indebted to Der Stein der Weisen.

SILK AND ITS PRODUCERS.

By R. LYDEKKER.

WHEREAS wool, fur, and hair are exclusively the products of a single class of vertebrate animals, namely, the mammalia, silk is as exclusively a product of invertebrate creatures. In place, however, of being produced by one single class, it is yielded in a workable form by certain members of at least three distinct classes of the lower animals, namely, the lepidopterous insects, the spiders, and the bivalve mollusks. At present, however, it is only the product of the caterpillars of a comparatively few species of moths that is of any real commercial importance.

Unfortunately the manufacture of raw silk into the finished article is one of those industries which have to a great extent passed out of the hands of the British workman into those of his foreign rivals; and the Spitalfields hand-loom weaver is almost as extinct as the dodo, while the ribbon-mills of Coventry have largely been superseded by cycle-manufactories.

According to an article which appeared a few years ago in Commercial Intelligence, it seems that during 1898 the imports into Great Britain of manufactured silken goods amounted to over twenty millions in value, while the imports of raw silk were only about one million. Inclusive of the necessary labor, the value of this imported raw material when worked up into silk goods would probably not be more than between two and three millions; and it would thus appear that out of a total consumption of some twenty-two or twenty-three millions sterling worth of manufactured silk only a very small fraction is made at home.

The British silk industry has, indeed, been gradually languishing and diminishing for a period of something over sixty years—practically during the whole of the Victorian era. In 1838, according to the same source of information, when the population of the British Isles was only twenty-five millions, the annual consumption of home-made hand-loom woven silken goods was equivalent to eight shillings and sixpence per head. In 1898, on the other hand, when the population was reckoned at about thirty-eight millions, the consumption of silk goods manufactured abroad was equivalent to ten shillings and sixpence per head, while that of British-made silk reached only a miserable eighteenpence per head.

It is not that hand-woven British goods are inferior in quality and wearing power to the foreign articles by which they have been so largely supplanted. Quite the contrary. And now that raw silk is exported from India, China, and Japan in much better condition for manufacture and at a lower price than in 1838, there seems no reason why it should not pay to work it up in this country.

Although the caterpillars of many species of moths make silken cocoons for the protection of their chrysalids, and the cocoons of several of these are used to supply commercial silk, the great bulk of the supply is afforded by the caterpillar of the silk-moth, the so-called "silk-worm." Curiously enough, the silk-moth is a purely domesticated animal, whose wild ancestor is now unknown. Even the real home of this insect is not definitely ascertained, some authorities believing northern China to be the original habitat of *Bombyx mori*, as the species is technically called, while others think that Bengal has a stronger claim to the honor. Be this as it may, the species has been domesticated for an immense period in China, some say since about 1640 B. C.; it was introduced into Constantinople in the sixth century of our era, whence it was carried into France in the year 1494. It is now distributed over a large portion of the globe; and as a consequence of such a wide range and such a long period of domestication it has altered considerably from the parent form, and has likewise developed several local modifications. Evidence of its alteration from the parent form (whatever that may be) is afforded by the aborted condition of the wings of the adult moth, which are so weak as to render the insect incapable of flight. By some it has been said that if the moths be reared in the open air in perfect freedom they will recover the power of flight in the course of a few generations, but since it is also stated that the caterpillars when turned out on trees are helpless, this requires confirmation. Variation is shown by the fact that in one breed the cocoon is yellow while in another it is white; and this, coupled with other variations, has led some authorities to believe that the domesticated form is derived from more than one wild species. This view has, however, not met with general acceptation.

The silk is found within the body of the caterpillar in a pair of glands of somewhat complex structure, and is there in a viscid condition. The ducts of the two glands unite into one common channel, so that their products are united before emission into a single thread which in the last part of the apparatus is coated with a kind of waterproof varnish. As "silkworms," probably owing to the artificial conditions under which they are reared and in-and-in breeding, are subject to many diseases, especially about the period of pupation, attempts have been made to convert the viscous matter in the bodies of the caterpillars into silk by artificial means. But although the secretion can be drawn out into threads of considerable fineness, it resembles catgut rather than silk, and has no power of resisting the effects of water. A still more bold attempt has been made, namely, to obtain silk direct from the mulberry leaves on which the silkworm feeds; but this, as might have been expected, resulted in complete failure, many of the workings in nature's organic laboratories being too subtle for imitation by any of the means at man's disposal. It may be added that although silk of good quality is produced by silkworms reared in Britain, the thread is so short as to render it of little or no commercial value.

The best and most valuable silk is yielded by the white cocoons; but of these there are two descriptions, known in the trade as first and second white. The yellow cocoons, which are the most numerous, are divided into three classes according to size; the small and medium-sized cocoons being of higher value than the larger ones. The cocoons of other breeds vary in color from greenish white to pure or reddish green; while there exists a Tuscan breed of silkworm which produces pale rose-colored cocoons, and purple cocoons have also been reported. The breed yielding white cocoons, known in France as *sina*, appears to have been produced from the yellow cocoon breed by careful selection, since a certain percentage of yellow cocoons always appears among the white ones. By the exercise of great care the percentage of yellow cocoons, which formerly had been much larger, was reduced many years ago in France to a very few per thousand.

The silk-moth is the typical representative of a family of moths (*Bombycidae*), characterized by the absence of a proboscis, and the presence of one internal nervure on the hind-wing. A second family of silk-producing moths—the *Saturniidae*—differ from the *Bombycidae* by the presence of two or three nervures in the hind-wing. Among these are some of the largest of all moths; and the majority of them are characterized by the presence of a clear transparent spot or "window" in the center of each wing; the transparency being, of course, due to the absence on these areas of the minute scales which cover the remainder of the wings. Hence they may conveniently be called window-moths. The use of this very peculiar type of marking is at present quite unknown, but it is probably of some considerable importance in the economy of these insects.

In Japan the great silk producer is a large yellow window-moth, measuring nearly seven inches across the wings, known as the yama-mai (*Attacus yamamai*), the caterpillar of which feeds on oak-leaves. It produces large green cocoons yielding an excellent silk, second only in quality to that of the silk-moth. For a long time the exportation of this insect was forbidden, but eggs from time to time found their way to Europe, where attempts were made to acclimatize such a valuable species. All these attempts were, however, attended by failure. Although the cocoons are bright green, the silk in their interior is of a silvery white.

Another species which it has been attempted to introduce into France is the Manchurian window-moth (*Attacus perryi*), whose caterpillar likewise feeds upon the oak. Cocoons were first sent to Lyons, from which moths were in due course hatched out, and shown at the Paris Exhibition of 1855. The silk has some of the properties of wool and cotton, as well as of ordinary silk, and thus approximates to the Tusser (or Tusseh) silk of India, a name which is commercially applied to the produce of many of the window-moths. Of the true Indian Tusser moth (*A. mylitta*), which is found both in lower Bengal and the Punjab, the silk is perhaps even more valuable than that of the species last named. The silk is so coarse and knotty that it has to be carded instead of wound, and from it are made the well-known khaki-colored tusser fabrics that are almost indestructible with fair usage. An excellent account of this moth and its silk is given by Mr. Cotes in an article on the "Wild Silk Insects of India," published in Indian Museum Notes for 1891, where mention is also made of other kinds of silk-producing species. Among these latter is the Atlas moth (*A. atlas*), which is one of the largest in the group. Its caterpillar is pale olive-green and lavender in color, with a conspicuous D-shaped scarlet mark on either side of the hinder end. Like those of other members of the group it is armed with a number of spine-like warts.

The species that has perhaps attracted the largest amount of attention is, however, the ailanthus moth (*A. cynthia*), which is a native of Japan, where the caterpillar feeds on the ailanthus, or false Japanese varnish-tree. The wings of this handsome moth are ornamented by a conspicuous white line, externally to which is another band of rose; each wing also having a crescentic spot. This fine species was introduced into France in 1857 or 1858, where it has since been acclimatized, its food-plant flourishing well in that country. At first the cocoons could be made to yield by carding nothing more valuable than short-fibered floss-silk, but subsequently means were devised of obtaining long threads of an excellent description of silk. The ailanthus moth is found in China as well as in Japan. In India it is replaced by the closely allied castor-oil moth (*A. ricini*), which yields a silk of very similar character. By some writers this species is regarded only as a variety of the last. Darwin, in his "Animals and Plants under Domestication," states, for instance, that "the Arrindy silk moth (as it is often called) introduced from Bengal, and the Ailanthus moth from the temperate province of Shan Tung, in China, belong to the same species, as we may infer from the identity in the caterpillar, cocoon, and mature states; yet they differ much in constitution; the Indian form 'will flourish only in warm latitudes,' the other is quite hardy and withstands cold and rain." Apart from its tender constitution, the difficulty of cultivating the castor-oil plant, even in the south of France, offers an obstacle to the permanent acclimatization in Europe of the first-named form.

Omitting mention of certain other silk-yielding caterpillars, a few lines may be devoted to the subject of spider-silk. The gossamer-like nature of this delicate substance is familiar to all; and in fineness and tenuity

the threads far surpass ordinary silk. From time to time more or less successful attempts have been made to utilize this substance; and recently a manufactory has been established in France where the ropes for military balloons are made from spider-silk. The factory is situated at Chalais-Meudon, near Paris. The spiders which supply the silk are arranged in dozens above a revolving reel, upon which the threads are wound; each spider furnishing from thirty to forty yards of thread. After the removal by careful washing of the reddish, sticky outer layer, the threads are twisted into a yarn, which, although considerably more expensive, is both lighter and stronger than a cord of caterpillar silk of the same caliber. One of the chief difficulties connected with the manufacture is the feeding of the spiders.

The third and last description of silk used for manufacture is afforded by the *byssus*, or mooring-rope of the great mussel-like bivalve commonly known by its Italian name *pinna*, a word which properly denotes the fin of a fish, but is applied to the shell on account of its fin-like shape. The pinna, which grows to a length of two feet or more, is a semi-translucent shell shaped like an isosceles triangle; the byssus issuing on one side from between the two valves a short distance from the apex. This byssus consists of a silk so fine in quality as to produce a most delicate fabric when worked up. Although the supply of this pinna silk is too limited to be of any commercial importance, it has from time immemorial been manufactured into small articles of dress, such as gloves, stockings, and caps, at Taranto. Originally these were reserved for imperial or royal use, and at the present day are made rather as objects of curiosity than of use; the manufactured silk is of a delicate hair-brown color. For some reason or other the pinna-silk is mixed with about one-third its bulk of ordinary silk previous to being woven. Some years ago the price asked for a pair of pinna-silk gloves at Taranto was six lire, while eleven lire were demanded for a pair of stockings. Specimens both of the byssus and of the manufactured silk are exhibited in the Natural History Museum at South Kensington.

In addition to its importance as the chief silk-producer of the world, the silk-worm also yields the finer descriptions of the substance known by the not very elegant title of "catgut." To obtain the catgut, or "gut," the silkworms must, however, be killed just before they commence cocoon-spinning, so that silk and gut cannot be obtained from the same individuals. Consequently the finer descriptions of gut, such as that used by the fly-fisher, are expensive.

The great manufactory of fine gut at the present day is situated on the island of Plocida, in the Bay of Naples, where, however, only a small proportion of the silkworms necessary for the manufacture are raised, the great bulk of these caterpillars being obtained from Torre dell Annunziata and other towns in the neighborhood, where there are large silkworm-breeding establishments.

According to an account published a few years ago, the process of manufacture of "fili di seta" ("silk-threads") as the gut is locally termed, is as follows: The silkworm is selected when fully matured, that is to say, at the moment when its nourishment ceases, and just before its metamorphosis. It is then cut open, great care being taken not to injure the membrane of the silk-glands there, which usually reach the length of thirteen to twenty millimeters, with a diameter of one and a half to two millimeters; these are then removed, and put into a pickle, which is the keynote of the whole process, and the secret of which is carefully kept. When the pickling process is over, the work-people, who are mostly women, take one end of the gland in their teeth and draw the other end with their hands. This part of the work requires great dexterity, for the threads are drawn out to the length of from thirty to fifty centimeters, and the whole value of the product depends upon its length in relation to its thickness, and the strain it will carry. There are two seasons for the production, namely, in spring, when the best gut is produced, and in autumn, when the quality is inferior. There is an important market for this specialty, and the whole production is exported to Northern Italy and abroad at the average price of one hundred and fifty lire per kilogramme. The gut is of very small specific gravity, so that a great deal of it goes to a kilo. The cost of production is also considerable, since the silk-worms must be bought just at the moment when they are coming into profit for making silk, that is to say, when they are at their dearest. Again, the results are frequently disappointing, many of the caterpillars being found, on dissection, unsuitable, so that they have to be rejected. —Knowledge.

THE FISH-FAUNA OF JAPAN—WITH OBSERVATIONS ON THE DISTRIBUTION OF FISHES.*

By DAVID STARR JORDAN, President of Stanford University.

THE islands of Japan are remarkable for their richness of animal life. The variety in climatic and other conditions, the nearness to the great continent of Asia and to the chief center of marine life—the East Indian islands—its relation to the warm Black Current of Kuro Shiwo—the Gulf Stream of the Orient—and to the cold current from Behring Sea, all tend to give variety to the fauna of its seas. Especially numerous and varied are the fishes of Japan.

About nine hundred species of fishes are known, from the four great main islands of Japan, and about two hundred more from the volcanic islands (Kuriles and Liukiu) to the north and south. Of the eleven hundred, about fifty are fresh water. All of these are derived from the mainland of Asia. Two faunal districts, the north and the south, may be recognized among the fresh-water fishes. The mountain region and the region lying to the north of Fuji abound in trout, with salmon, sturgeon, lamprey, and other northern fishes. In the southern district these are absent, and the chief fresh-water fishes are ayu, or dwarf salmon, chubs, minnows, cat-fishes and loaches.

The marine fishes are far more varied, their distribution being mainly controlled by temperature and currents. Among these, six districts may be recognized, their range sufficiently indicated by the names Kurile, Hokkaido, Nippon, Kiusiu, Kuro Shiwo, and Liukiu. Of these the Kurile fauna is subarctic, similar to that of the Aleutian Islands, that of the Liukiu Islands is tropical, that of the promontories, which strike out into the Kuro Shiwo, is Polynesian. The central region (Nippon) contains the forms essentially Japanese. Kiusiu has much in common with China, and Hokkaido with Siberia and Manchuria. Each of these districts overlaps, by a broad fringe, on the others.

It has been noted that the fish fauna of Japan bears a striking resemblance to that of the Mediterranean, and Dr. Gunther has suggested that this can be accounted for by supposing that in recent times a continuous coast line and sea-passage extended from one region to the other, the Isthmus of Suez not existing.

The resemblance consists in the presence in the two regions of certain striking looking fishes, not found in other parts of the world. An analysis of these resemblances takes away much of their impressiveness. Most of the forms in question are widely distributed, ranging from Japan through India to the Cape of Good Hope. Only three genera are restricted to Japan and the Mediterranean. Resemblances equally strong exist between Japan and the West Indies, or between Japan and Australia. The differences are equally marked; no types which seem to be of Japanese origin are found in the Mediterranean. Those of Mediterranean origin are wanting in Japan. There are two main reasons why one fish fauna may resemble another; the one, actual connection, so that fishes migrate from one region to another; the other, similarity of physical conditions, favoring in each region the development of similar kinds of fishes. The evidence points toward the theory that similarity of physical conditions is the chief source of resemblance between Japan and the Mediterranean. The resemblance between Japan and the West Indies is due to this cause, while that of Japan to the East Indies is due largely to direct connection. If Japan and the Mediterranean were ever connected, the Red Sea must have been a region of junction. Yet, while the Red Sea in its fishes closely resembles southern Japan, it has almost nothing in common with the Mediterranean, except a few shallow water or brackish water types, the shore fishes of the two regions are wholly distinct, none of the characteristic genera of either sea being found in the other.

Yet geologists affirm that in Pliocene or Post-Pliocene times the Isthmus of Suez was submerged. It is made up of Pliocene deposits with alluvium from the Nile and drifting sand-hills. Admitting this to be true, the nature of fishes shows that this connecting channel must have been very shallow and probably in part occupied by fresh water. No bottom fish or rock-fish has crossed the Isthmus of Suez; only sting-rays, torpedoes, eels and mullets appear to have passed from one side to the other. It must have been impossible for Japan and the Mediterranean ever to have exchanged their ordinary shore fishes in this way. The only other alternative is to suppose that the forms common to these two regions have passed by Cape of Good Hope, and this barrier is, to this day, passed by many characteristic fishes of both oceans.

Four hundred and eighty-three genera of fishes are known from Japan. For the purpose of our present study we must take from this list all the fresh-water types derived from China; all the northern types, derived from Behring Sea and the general Arctic stock; all the pelagic fishes, at home in the open sea, and all the bassalian fishes, or those inhabiting great depths below the range of climatic changes. After these are withdrawn, we have left the shore fishes of tropical or semi-tropical origin. Of these Japan has 334 genera; the Mediterranean, 144; the Red Sea, 191; India, 280; Australia, 344; New Zealand, 108; Hawaii, 144; West Indies, 299, and the Panama region, 256.

Common to Japan and the Mediterranean are 79 genera, all but two being genera of wide distribution; to Japan and the Red Sea, 111; to Japan and Hawaii, 82; to Japan and Australia, 135; to Japan and the West Indies, 113; to Japan and Panama, 91. To the Mediterranean and the Red Sea, 40 genera are common, all of wide distribution; to the West Indies and the Mediterranean, 70, 59 of them of wide distribution; to the West Indies and Panama, 179, only 101 being of wide distribution.

It is evident from an analytical table that the warm water fauna of Japan, like that of Hawaii, is derived from that of the East Indies and Hindostan; that the fauna of the Red Sea is derived from the same source; that the Mediterranean fauna bears no special resemblance to that of Japan rather than to that of other parts of Eastern Asia with like conditions of temperature, and no greater resemblance than is borne by the West Indies; that the fauna of the two sides of the Isthmus of Suez have relatively little in common; on the other hand those of the two sides of the Isthmus of Panama show a remarkable degree of identity so far as genera are concerned.

When the fishes of Panama were first described, it was claimed that their species were almost entirely identical with those of the West Indies; this statement was followed by speculations on the relation of the depression of this Isthmus to the Gulf Stream, and to the glacial epoch. Further investigations by Jordan, and by Evermann and Jenkins, showed the fallacy of this claim of identity of species. Of about 1,400 species now known from the two sides of the Isthmus of Panama, only 70 are identical, or five per cent of the whole, and about 10 of these are almost cosmopolitan in the tropics. Dr. Paul Fischer finds about three per cent of the mollusks identical on the two coasts.

Dr. R. T. Hill goes on to show that there is neither geological nor biologic evidence of the submergence of the Isthmus of Panama since Tertiary times, and that the isthmus existed as a barrier as far back as Jurassic times. There is, however, evidence of a brief connection in Tertiary times at the end of the Eocene period.

Assuming this to be true, the actual facts of distribution seem to be in accord with it. The period of depression was before the lifetime of most of the present species. It was, however, not earlier than the period of most of the present genera. It was relatively shallow, but wide enough to permit the infiltration from the Caribbean Sea to the Pacific of species representing most of the genera of sandy bays, rocky tide pools and brackish estuaries. Since the channel was closed, the species left on either side have undergone modification in varying degrees, mostly retaining generic identity, while losing some of their specific characters.

Doubtless, local oscillations in coast lines have taken place and are even in operation at present, but the time has passed when a dance of continents can be invoked to explain anomalies in animal distribution. Most of these anomalies will be found to have simple causes, when we know enough of the facts in the case to justify a hypothesis.

The laws governing animal distribution are reducible to three very simple propositions:

Every specimen of animal is found in every part of the earth having conditions fit for its existence, unless:

(a) Its individuals have been unable to reach the region in question through barriers of some sort; or,

(b) Having reached the region, the species is unable to maintain itself through lack of capacity for adaptation, through severity of competition with other forms, or through destructive conditions of environment; or else,

(c) Having entered and maintained itself, it has become so altered in the process of adaptation as to become a species distinct from the parent type.

In general, the different types of fishes are most specialized along equatorial shores. The processes of change through natural selection take place most rapidly there and produce more far-reaching modifications. The coral reefs of the tropics are the centers of fish-life, corresponding in fish economy to the cities in human affairs. The fresh water, the Arctic waters, the deep sea and the open sea, represent ichthyic backwoods—regions where change goes on more slowly and in which Archaic types survive.

The study in detail of the distribution of the fishes of the tropics is most instructive. The study of the origin of the fish groups of Japan affords a fascinating introduction to its multifarious problems.

* Abstract of Address delivered before the section of Zoology, American Association for the Advancement of Science, Denver Meeting, August 1901.

BEYROUT.*

THE old-time semi-savage towns collected round the landing-places or "scale" of the Eastern Mediterranean shores are passing away. Turko-Arab barbarism is gradually melting before the influences of civilization, and in the very midst of the Nearer East the excellent port built by French enterprise in 1895-1900 has raised Beyrout from a mere agglomeration of rich natives' houses (filled with women and slaves), the consulates, and a few traders' stores, into the position of a thriving and important city. The Arab slums of former days are of course still very much in evidence, but the large European houses and business premises built round the port are encroaching on the adjoining filthy hotels and lanes, and the leaven of enterprise and commercial development is working wonderfully. Beyrout illustrates the strange fusion of Eastern and Western ideas which can only be found in full force in Turkey.

A most singular feature in the civilization of Beyrout is the total absence of the civic organization associated with such events in other lands. Certainly there is a "medglis," or town council, partly elected by suffrage of Ottoman subjects, Christian as well as Mohammedan. But such an organization, in which all the foreign elements of the community, who represent the wealth and intelligence, are excluded, is naturally of very little value for practical municipal work. There is no regular civic corporation responsible for the public welfare, no government commission is charged with improvements, and not even the element of any committee of influential inhabitants enters into the question. A city of 200,000 inhabitants manages to exist in a flourishing fashion with merely a nominal administration representative of the minority, and under the control of the innately corrupt Turkish government.

Everything in Beyrout naturally reflects that characteristically selfish mode of life which is inseparable from Mohammedan institutions. There is no conception of co-operation for mutual welfare, no public spirit, no union of common interests for a common good. Every man seizes and holds such property as he can come by in any way, and his one idea is always to surround such property with barriers of defense, on the outside of which any trifling display of his possessions is always of the most cautious and guarded kind. As a consequence this is a country where real public works are practically unknown, and anything in the shape of a monument or object of public utility—a mosque, a bridge, a drinking fountain—is merely the result of individual caprice and desire for display. Such monuments are, of course, never repaired or re-erected when once they are decayed or destroyed. Roads may be said to hardly exist with the exception of the famous Damascus-Beyrout road, made and maintained by the French Diligence Company since 1860. This company, afterward merged into the railway company, still owns the road, but the older work is now no longer sustained as formerly, and the greater part of it has lapsed after the last few winters into a ruin. Under these circumstances, all the imposing modern buildings which are springing up in Beyrout and its suburbs have an old and anomalous effect to a European accustomed to the properly laid-out streets, well-made roads, etc., of a civilized town.

As an illustration of the shocking disregard for the welfare of the community displayed by the Turkish officials of such a town as Beyrout, a most terrible accident last year occurred in one of the quite European quarters of the city. A three-storied house, built a few years back, falling down, killed forty-seven persons. The property belonged to a Mohammedan speculative builder. As there is no real or effective control over the erection of such buildings in modern Turkey, and the "jerry builders" are now a good deal occupied in providing houses in a supposed European style for the European natives, many more of these disasters may unfortunately be looked for in the near future. At present the influences of the "evil eye" and "kismet" seem supposed to sufficiently explain the cause of such disasters.

The natives of Syria are comparatively poor; the

* The Builder.

small amount of wealth existing in the country is very fairly distributed, and although there are few beggars compared with a European district of similar proportions, the number of families living in affluence is very small indeed. This is due to several causes—the insecurity of property, simplicity of life, want of energy on the part of the natives, and, perhaps more than anything else, to the enervating influences of a warm climate, which has a deteriorating effect on humanity in all parts of the globe. At the same time it must be admitted that a certain amount of native enterprise is observable in Beyrout, fostered by the presence of the corps of foreign consuls, who in the Levant occupy a quite different position from that of mere commercial agents, such as are found in other countries, for here they are viewed as protectors from Turkish officialism.

In Levantine countries the Jewish race is, perhaps the most important factor in social development. Thanks to the numerous Jewish immigration societies founded in the seventies and eighties by English and other Protestant enthusiasts, the whole face of Palestine and some part of Syria has been changed. Instead of a sleepy, uncared-for province of the Turkish empire, with a limited population of Arabic-speaking "felaheen" under the rule of a patriarchal government, many of the officials of which were genuine Turks from Constantinople in former times, the country has now become a center of colonial activity unlike that of any other part of the world. And this remarkable change has taken place since the introduction of the Jewish colonies at the time of the Mansion House Relief Fund. Now, in addition to the Jews, there are flourishing settlements of Germans and Americans everywhere, and some evidences of Russian influence; but the most noticeable addition to the modern population of the country is, perhaps, the great and increasing influx of Mohammedan refugees from countries whence they are being ousted by Christians. The Jewish element in Beyrout is, as might be expected, greatly evidenced by the large new places of business belonging to Jewish traders with more or less European names. One of the largest and most imposing of these establishments is an enormous store for the sale of every conceivable article for household use or wearing apparel, resembling the famous "Fratelli Bocconi" shops of Italy or the "Magasins du Louvre." It stands on the quay of the new port, and although hardly to be criticised from an architectural point of view, its immense stone front, plate-glass windows, and Parisian appearance create a very astonishing effect on the mind of the traveler returning to Beyrout after the lapse of ten years.

THE MANUFACTURE OF ARMOR PLATE.

The manufacture of armor plate for vessels of war is much more complicated than it used to be, and comprises a certain number of successive operations. The first is that of casting the ingot which is to be transformed into an armor plate. The ingot, which weighs from 70 to 80 tons, is carried to the room containing the presses and put into the reheating furnace in order to be raised to a temperature that will permit of its form being changed. The time necessary to effect such heating is, for large ingots, from 18 to 24 hours. The ingot is carried by a 150-ton traveling crane to the hydraulic press designed to flatten it. The large presses are huge affairs, weighing 800 tons, and of 8,000 horse power. They consist of two hydraulic cylinders 3.28 feet in diameter with a 10-foot stroke. They are supported by cast steel cross pieces held by four forged steel columns. Such a system is sufficient for exerting a pressure of 7,150 pounds to the square inch, although in practice scarcely 5,700 pounds are exceeded. The press is actuated by steam pumps. The levers that control the press, those of the traveling cranes that support the ingot and those for driving the different tools are placed side by side. The work can thus be performed with truly extraordinary facility. The apparatus through which the ingot is suspended is so arranged as to permit the latter to be turned over so that the two faces can be flattened in succession. With the enormous power of the hydraulic press, an ingot 4.25 feet in diameter is converted into a plate 14 inches in thickness and its length increased from 6 to 21 feet in about an hour. When the plate is to pass to the rolling mill, a length of the proper thickness is produced and its end clipped off. The plate rolling mill is a massive machine provided with two forged steel cylinders nearly 3 feet in diameter, 12 in length, and each weighing twenty tons. A steam engine actuates them at a pressure of 72 pounds to the square inch. The mill is accompanied with a traveling crane capable of lifting 60 tons. The feed rollers extend to within 42 feet of the compressing cylinders. The mill is capable of reducing a 30-inch plate to 6 inches at a single heating. The press and mill are thus capable of working four large plates a day. Upon its exit from the rolling mill the plate is cooled, and specimens are then taken from it in order to ascertain the tenacity or other properties of the metal.

The next operation is case hardening. This consists in heating two plates separated by a layer of charcoal and enveloped with bricks and sand. This system is placed in a gas furnace and submitted to a high temperature for fifteen days, at the end of which the surfaces in contact with the charcoal have had the time necessary to become sufficiently carbureted. Immediately after carburetion, the bending is done. The plate is reheated and the curvature desired is given in the large press. The plate is placed upon a

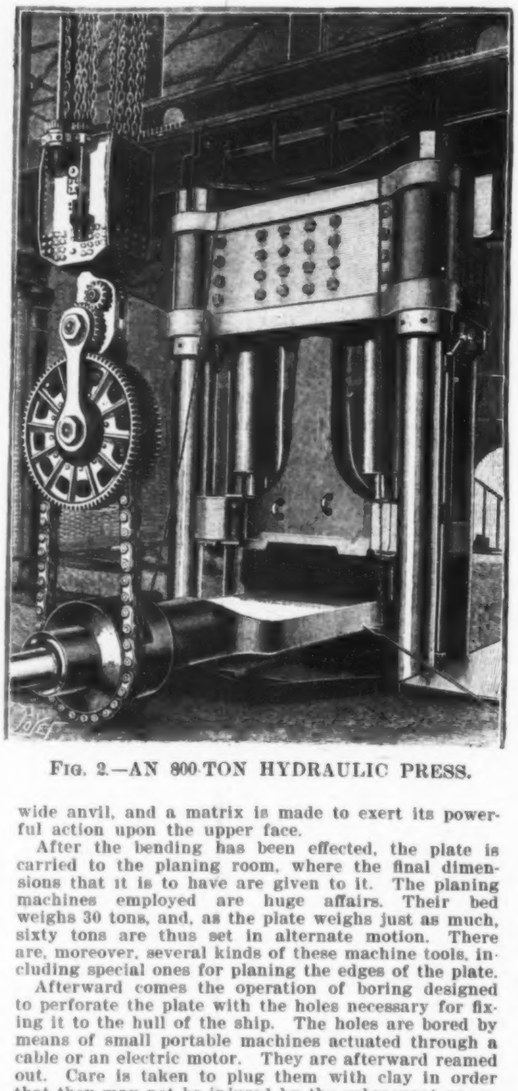


Fig. 2.—AN 800-TON HYDRAULIC PRESS.

wide anvil, and a matrix is made to exert its powerful action upon the upper face.

After the bending has been effected, the plate is carried to the planing room, where the final dimensions that it is to have are given to it. The planing machines employed are huge affairs. Their bed weighs 30 tons, and, as the plate weighs just as much, sixty tons are thus set in alternate motion. There are, moreover, several kinds of these machine tools, including special ones for planing the edges of the plate.

Afterward comes the operation of boring designed to perforate the plate with the holes necessary for fixing it to the hull of the ship. The holes are bored by means of small portable machines actuated through a cable or an electric motor. They are afterward reamed out. Care is taken to plug them with clay in order that they may not be injured by the subsequent operation of tempering.

The tempering requires that the plate shall be first heated to the necessary temperature. This operation is performed in a furnace analogous to those already mentioned. The plate, heated to the degree desired, is put upon an iron grate, and a sprinkling apparatus wets both of its faces. The pressure of the water is such as to prevent the formation of steam in contact with the plate, which would retard the effect of the tempering. The sprinkling lasts three hours, and, during this time, no less than four or five tons of water fall upon the plate. The hardening thus produced reaches a depth of from 1 to 1½ inches.

Finally, the last operation consists in the grinding designed to give the plate its finish. The grinders are fixed upon a cast iron disk set in operation by a 30 H. P. electric motor furnishing 400 revolutions a minute. The apparatus is capable of assuming every possible inclination in order to attack all points of the plate.

Upon the whole, the various successive operations in the manufacture of a large armor plate are the following: Casting of the ingot; flattening in the hydraulic press; rolling; case hardening; bending; planing; boring; tempering, and grinding.—For the above particulars and the engraving we are indebted to La Nature.

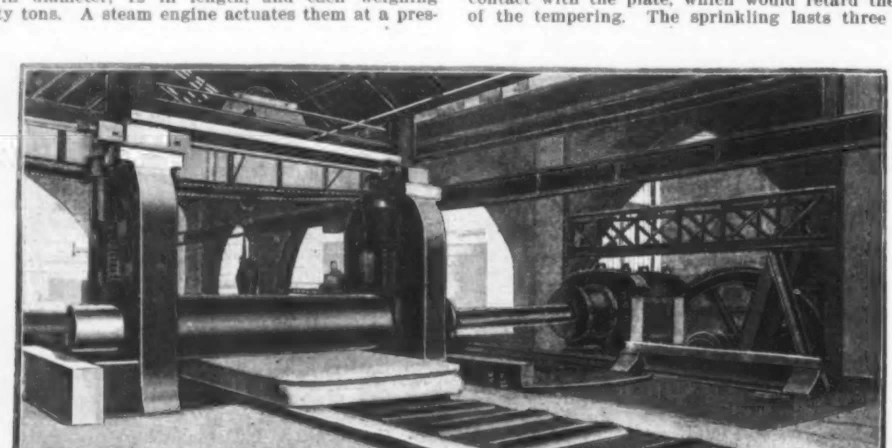


Fig. 1.—ROLLING MILL FOR ARMOR PLATES.

THE SHIP CANALS OF THE WORLD.*

Ship canals connecting great bodies of water and of sufficient dimensions to accommodate the great modern vessels plying upon such waters are of comparatively recent production and few in number. The one great example of works of this character which has been of sufficient length of time in existence and operation to supply satisfactory data as to cost of maintenance and operation and practical value to the commerce of the world is the Suez canal, and for this the available statistics begin with the year 1870, while its new and enlarged dimensions only date from the year 1896. For the Sault Ste. Marie canal, connecting Lake Superior with Lake Huron, statistics date from 1855, though for the canal in its present form they cover but about four years. Statistics of the Welland canal date from 1867, but for the canal in its present enlarged form cover only two years of operation. The other great ship canals of the world are of much more recent construction and data regarding their operation therefore cover a comparatively brief term, and in some cases are scarcely at present available in detail.

The artificial waterways which may properly be termed ship canals are nine in number, viz.:

1. The Suez canal, begun in 1859 and completed in 1869.
2. The Cronstadt and St. Petersburg canal, begun in 1877 and completed in 1890.
3. The Corinth canal, begun in 1884 and completed in 1893.
4. The Manchester ship canal, completed in 1894.
5. The Kaiser Wilhelm canal, connecting the Baltic and North Seas, completed in 1895.
6. The Elbe and Trave canal, connecting the North Sea and the Baltic, opened in 1900.
7. The Welland canal, connecting Lake Erie with Lake Ontario.
8 and 9. The two canals, United States and Canadian, respectively, connecting Lake Superior with Lake Huron.

The description which is given of each of these great waterways shows that the length of the Suez canal is about 90 miles, the cost $100,000,000, the present depth 31 feet, width at bottom 108 feet and at the surface 420 feet, and that the number of vessels passing through it has grown from 486 in 1870 to 1,494 in 1875, 2,026 in 1880, 3,389 in 1890, and 3,441 in 1900. The tolls charged are about $2 per net registered ton.

The Cronstadt and St. Petersburg canal, which gives a passageway for great vessels to St. Petersburg, is 16 miles long, including the deepening of the bay channel, 20½ feet in depth, and the total cost is estimated at $10,000,000.

The Corinth canal, which connects the Gulf of Corinth with the Gulf of Aegina, is four miles in length, 26¼ feet in depth, 72 feet wide at the bottom, cost about $5,000,000, and reduces the sailing distance about 175 miles. The average tolls charged are 18c. per ton and 20c. per passenger.

The Manchester ship canal, which connects Manchester, England, with the Mersey River and Liverpool, was opened in 1894. Its length is 35½ miles, depth 26 feet, width at bottom 120 feet, and at the surface 175 feet, and cost $75,000,000. The commerce on the canal shows a growth from 879,204 tons in 1895 to 1,492,320 tons in 1900.

The Kaiser Wilhelm canal, which connects the Baltic and North Sea through Germany, is 61 miles in length, 29½ feet in depth, 72 feet wide at the bottom, 190 feet wide at the surface, and cost about $40,000,000. The number of vessels passing through it has increased from 19,960 in 1897 to 29,095 in 1900, of which number 16,776 were sailing vessels. The tonnage in 1897 was 1,848,458, and in 1900, 4,282,094 tons. An additional canal connecting the same bodies of water by way of the Elbe and Trave Rivers was opened in 1900. Its length is 41 miles, depth about 10 feet, width 72 feet, and cost $6,000,000.

The great North Holland canal, which connects Amsterdam with the sea, cut in 1845, but deepened at a later date, has now a depth of 20 feet, a width of 125 feet at the surface. The Caledonia canal, which connects the Atlantic and North Sea through the north of Scotland is 17 feet in depth, 50 feet in width at the bottom, 250 miles in length, cost $7,000,000, and is at its highest point 94 feet above sea level.

The Canal du Midi, cut through France from Toulouse on the Garonne to Cette on the Mediterranean, a distance of 150 miles, is 6½ feet deep, 60 feet wide, and 600 feet above sea level at its highest point, and has 114 locks; total cost, $3,500,000.

In America the canals connecting the Great Lakes are the principal ship canals and are three in number: the Welland canal, originally constructed in 1833 and enlarged in 1871 and 1900; the Sault Ste. Marie, or St. Mary's River canal, opened in 1855 and enlarged in 1897; and the Canadian canal at St. Mary's River, opened in 1895. The American and Canadian canals at St. Mary's Falls are practically identical in location and dimensions, and are used interchangeably by vessels engaged in commerce, as convenience may dictate. The depth of the canals at the St. Mary's River is sufficient to accommodate vessels drawing 20 feet of water. The American canal was originally constructed by the State of Michigan, but subsequently taken charge of by the United States and enlarged at a cost of $2,150,000.

* From U. S. Treasury Bureau of Statistics.

The cost of the Welland canal was about $30,000,000, largely due to the fact that 25 locks are required in surmounting the rise of 327 feet in the distance of 27 miles. The number of vessels passing through the canals at St. Mary's River has greatly increased during the past few years, while the number passing through the Welland canal has materially decreased; the number passing through the St. Mary's canals being in 1873, 2,517, and 1901, 20,041, of which 15,837 passed through the United States canal, and 4,204 through the Canadian. The number of vessels passing through the Welland canal has decreased from 6,425 in 1873 to 2,202 in 1899. The marked contrast between the business of the St. Mary's Falls and Welland canals is largely due to the fact that the freights originating in the Lake Superior district are chiefly discharged at Lake Erie ports, and those destined for the Lake Superior region are chiefly produced in the section contiguous to Lake Erie, the Lake Superior freights being chiefly iron, copper and grain, and the Lake Erie freights for Lake Superior, coal and manufactures. The business of the St. Mary's Falls canals by far surpasses in volume that of any other canal of the world, the freight tonnage of the American and Canadian canals combined being in 1901, 24,626,976 registered tons, while the net tonnage of the Suez Canal in 1900 was 9,378,152 tons, and that of the Kaiser Wilhelm canal 4,282,094 tons.

THE NEW ENGLISH BATTLESHIP TYPE "KING EDWARD VII."

THE very correct conclusion of the English Navy Department that in view of the eagerly pursued development of the navies of other powers, it is no longer possible for Great Britain to add a correspondingly strong new vessel to the British navy for every new foreign man-of-war, has led to a continual increase of the armament and protection on the British vessel, in order to thus remain superior to all other nations, at least in the fighting strength of the single vessels. This end could, however, be attained only by considerably increasing the displacement of the vessels, and thus the giants of the "Royal Sovereign" class with 14,150 tons, of the "Majestic" class with 14,900 tons, and the "Formidable" class with 15,000 tons displacement, sprang into existence, while the German men-of-war of the "Brandenburg" class are only of 10,062 tons, those of the "Kaiser" class only of 11,152, and those of the "Wittelsbach" class only of 11,800 tons displacement.

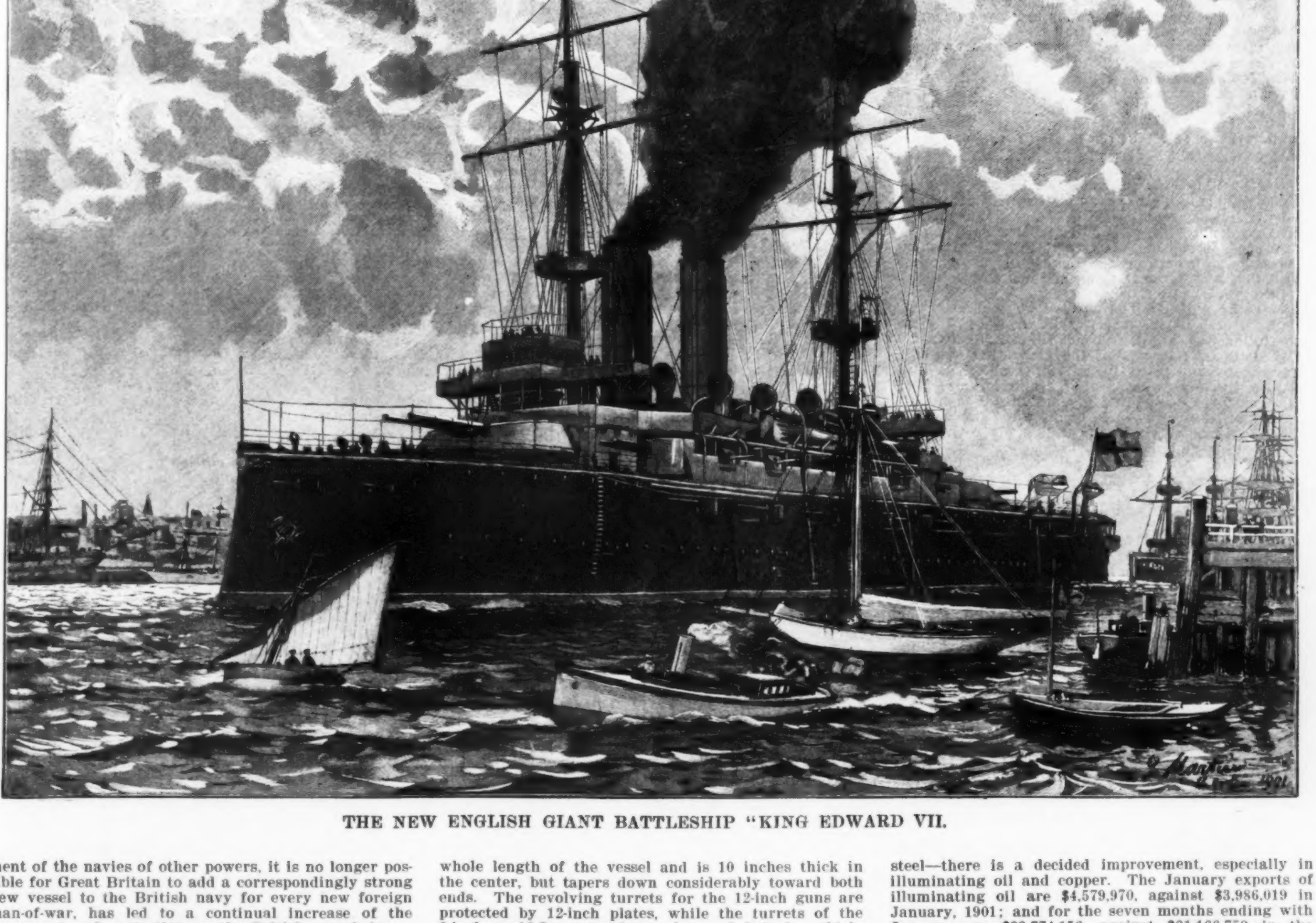
The armament of the new large men-of-war consists nowadays almost invariably of four heavy and twelve to eighteen medium-heavy guns, as well as of a large number of guns of smaller caliber. Only a few American battleships and the vessels of the "Brandenburg" class, if the latter may still pass as modern war vessels, form an exception. But now England intends to treble the number of heavy guns on her war vessels to be constructed, without appreciably increasing the mean artillery. The new vessels are to receive four 12-inch guns, eight 8-inch and ten 6-inch rapid-fire guns, as well as a large, still unsettled number of smaller quick-fire guns and machine guns. Conforming to the resulting extra load, the displacement of the new giant men-of-war will be 18,000 tons, with a length of 401 feet and a width of 74 feet.

For the time being three vessels of the new type will be built, bearing the names, "King Edward VII.," "Commonwealth" and "Dominion," our illustration showing the "King Edward VII." as the first representative of the new type. As will be seen, the four heaviest 30.5-centimeter guns are placed in two strongly armored revolving turrets forward and aft, while the eight next heaviest ones are mounted in turrets situated respectively diagonally behind the forward revolving turret and diagonally before the revolving turret of the 12-inch gun aft. This disposition renders it possible to fire six heavy guns simultaneously forward and aft in opposite directions, while eight heavy guns can be used on one side, port or starboard. Of the ten 6-inch rapid-fire guns, five are mounted on each side, and the smaller guns and machine guns are placed, like in other battleships, partly on the superstructures and partly on the fighting tops of the two masts. The torpedo armament will consist of four submerged tubes for 18-inch torpedoes, two on each side. The new vessels will have no tubes at the bow or stern.

Like all the large warships of the British navy, the vessel will have twin screws and two engines of 18,000 horse power for both, which will give the ship a speed of 19 knots per hour. The maximum coal bunker capacity will be 2,500 tons, in order to give the vessel as large a radius of action as possible, and thus rendering it more independent of the coaling stations. The armor belt on the waterline extends over the whole length of the vessel and is 10 inches thick in the center, but tapers down considerably toward both ends. The revolving turrets for the 12-inch guns are protected by 12-inch plates, while the turrets of the 8-inch rapid-fire guns have plates of 9 inches thickness. The armor of the casemate is 6 inches thick. Of the same thickness are the plates of the after conning tower, while the forward conning tower, as the usual position of the captain or the commander of the squadron, has armor of the same thickness as the turrets for the 12-inch guns. The arrangement of the boats is the same as customary on all modern battleships. Forward of the foremast and aft of the mainmast is one high bridge deck each, with the necessary command accessories such as speaking tubes, telephone, machine telegraphs, etc., so that the guidance of the vessel can be accomplished from both places. Like all the new vessels of the English navy, this one will receive an equipment for wireless telegraphy, which is being more and more introduced on board of the ships, having already attained a high state of perfection.

The English naval officers expect much from the new vessels and are of the opinion that they will be able, in consequence of their far superior artillery, to put any hostile battleship *hors de combat* in a short time. Other navies maintain a waiting attitude. The chief thing remains, no doubt, to handle the guns right, and as regards markmanship the gunners of the English navy do not occupy the first place.

For our illustration and the accompanying details we are indebted to Illustrirte Zeitung.



THE NEW ENGLISH GIANT BATTLESHIP "KING EDWARD VII.

UNITED STATES EXPORTS.

THE export figures for the month of January and the seven months ending with January, 1902, just completed by the Treasury Bureau of Statistics, show an improvement in the outward movement of manufactures. In the month of January, 1902, the exports of manufactures amounted to $34,412,992, against $32,654,035 in January, 1901, and are the largest shown in any January except 1900, when the total was $35,586,940. Compared with January, 1901, it will be seen that the figures show a gain of nearly $2,000,000 in the exports of manufactures. For the seven months ending with January the exports of manufactures are about thirteen millions less than those for the corresponding period of the fiscal year 1901. Indeed, manufactures for the month of January show greater evidence of activity in the export trade than any other class of our exports, being the only great class of exports which shows an increase in January, 1902, over January, 1901. Agricultural exports in January, 1902, fall eight millions below those of January last year, while products of the mines, forests, and fisheries are in January, 1902, slightly bedow those of January, 1901; while manufactures, as above indicated, are nearly two millions greater than those of January, 1901. In the three great articles in which manufactures had shown a decline during the past year—illuminating oil, copper manufactures, and manufactures of iron and steel—there is a decided improvement, especially in illuminating oil and copper. The January exports of illuminating oil are $4,579,970, against $3,986,019 in January, 1901; and for the seven months ending with January are $33,774,156, against $31,166,759 in the seven months ending with January, 1901, and $33,239,556 in the corresponding months ending with January, 1900, thus exceeding the highest preceding record in the value of exports of mineral oil during the period under consideration. In copper manufactures the exports of January are valued at $3,965,632, against $3,790,364 in January of last year. The quantity exported has very largely increased, the total number of pounds of copper ingots alone (which form the bulk of copper manufactures) being in January, 1902, 32,085,041 pounds, against 22,270,030 pounds in January, 1901, and 28,389,422 in January, 1900. For the seven months, however, the exports of copper manufactures are still about nine million dollars below those of the corresponding seven months of the preceding fiscal year. It will be observed that the quantity of copper exported has greatly increased, though the value shows but a comparatively slight increase. The only item of importance in the list of manufactures exported which still shows a reduction is that of iron and steel, which falls in January about a million and a half dollars below the figures of January, 1901, being in January, 1902, $8,088,958, against $9,610,552 in January,

1901, and $10,218,628 in January, 1900. For the seven months the total exports of iron and steel manufactures were valued at $57,290,128, against $73,616,467 for the seven months ending with January, 1901, and $66,504,-611 for the corresponding seven months of 1900.

The continued activity of the American manufacturer, which is shown in the steady outward movement of all manufactures except in the one class above noted, is further illustrated by a remarkable increase in the importations of manufacturers' materials. The Bureau of Statistics classifies the importations into five great groups: foodstuffs, raw materials for use in manufacturing, materials partially or wholly manufactured for use in manufacturing, finished manufactures, and luxuries. In these five great divisions the chief increase is in manufacturers' materials. They show in the single month of January an increase of seven and a half million dollars, and in the seven months ending with January an increase of fifty million dollars, compared with the corresponding periods of the preceding fiscal year. The total increase in importations during the seven months ending with January is sixty-seven million dollars, of which fifty million dollars is in manufacturers' materials.

[Continued from Supplement No. 1366, page 21892.]

ELECTRIC RAILWAYS.*

By Major P. Cardew.

GENERATION AND TRANSMISSION.

We now come to the generation and transmission of the electrical energy, and the question: How far apart the generating stations should be?

Although so much doubt exists at present as to the relative advantages of continuous and polyphase current for driving the trains, there is a general agreement that for the long distance transmission the right thing is three-phase current. There are great difficulties in the construction and winding of continuous current machines for even moderately high pressures, and of large power. Two thousand five hundred volts is about the practical limit, and this would necessitate generating stations spaced about ten miles apart, and even then the expense of mains, or the loss in transmission, would be very considerable.

With three-phase machines, however, pressures of 15,000 or 20,000 volts are quite practicable, and the limit is determined not by the generator, since the pressure may be raised by transformation at the generating station, but by the conditions of safe working of the transmission line and apparatus. I do not myself think it probable that the electrical pressure will in this country much exceed what is already being worked, whether the transmission be by underground cables or possibly by overhead wires. At a pressure of 12,000 volts at the generating station, and a density of 600 amperes per square inch in the cables, a density which should not be exceeded in high pressure cables of large size, energy may be transmitted fifteen miles by three-phase current with a loss of only 5 per cent, or with this loss the generating stations may be situated thirty miles apart.

Putting the saving to be effected by concentration of plant as high as the most fervid advocate of such concentration can expect, I do not think it likely that it will justify the spacing of the generating stations at more than from thirty to fifty miles apart, having regard to the heavy expense of transmission lines, and the continual waste of energy, and also the amount of dislocation of service caused by a serious breakdown. Electrical effects which are inconsiderable with ordinary pressures and distances, become of formidable magnitude when certain limits are exceeded. I allude especially to effects of what is called "capacity" and "inductance" in cables.

Future developments and discoveries may very probably alter the conditions, but as they are to-day, I regard 12,000 volts and transmission to 15 to 25 miles as good limits to adopt.

The use of the three-phase current for transmission from the generating stations to the sub-stations, where the conversion from the high pressure to the lower pressure supplied to the trains takes place, effects some economy in capital cost compared with continuous current transmission, even assuming equal working pressure possible in the two cases. The amount of copper necessary with three-phase transmission is only 75 per cent of that required for simple phase or continuous current with a non-inductive load, such as supply to lamps, or where the current can be kept "in phase" with the pressure, as when supply is given to "rotary converters." Even when the load is inductive, a saving from 15 per cent to 20 per cent of copper is practicable. On the other hand, three separately insulated conductors must be used, and each of these may acquire the full potential from earth as well as from the other two.

With continuous or single-phase current the cables used may be concentric, the outer conductor being earthed at one point and only differing in potential from the earth at any other point by the amount of fall of potential due to its resistance and the current passing in it. Thus a very slight insulating covering is sufficient for the outer conductor, and it may be handled while under pressure without any risk.

With two-phase current also concentric cables with earthed outer conductor may be used, but with three-phase current and three conductors all the conductors should be similar as regards insulation. On this account the practical saving effected by the use of three-phase current with underground cables is not very important, and would not of itself justify the use of the system as it certainly does in the case of long distance transmission where bare overhead wires can be used and the cost of copper is the chief expense.

TRANSFORMING STATIONS.

It is in the number and equipment of transforming stations that the system of using three-phase current to supply the motive power for the trains has a great advantage over any system using continuous current, in that with the latter the electric pressure is practically limited to about 500 volts, and the conversion from the higher pressure which must be used for the long distance transmissions requires the use of running machinery, whereas with the former, 3,000 volts is quite practicable, and higher pressure may be reached and conversion is carried out by means of statical transformers alone. The reason for the fixed limit of pressure with continuous current is that the motors cannot be constructed to take a pressure high enough to admit of the charged conductors being overhead wires, while if they are put in the permanent way a pressure of 500 volts is quite high enough considering the risk of accidental contact with those conductors to which the employés must be exposed.

It is very difficult in electrical engineering to set a fixed definite limit. What is the *ne plus ultra* of to-day may be merely the starting point of to-morrow. Still it certainly appears unlikely that for continuous current traction motors the limit of 500 volts will be much exceeded.

I believe that in one instance in America those conductors have been placed in a form of conduit beneath the track, but this again is an expensive arrangement, and involves greater liability to faults of insulation and short circuits. On the other hand, once get the conductors overhead on a railway line, where they can be kept perfectly free from crossing wires, which have caused several serious accidents on trolley lines, and many of the difficulties connected with line equipment are removed.

If continuous current is to be used for supply of power to trains, the conversion from the three-phase high pressure transmission system is generally accomplished by means of statical transformers to reduce the pressure and rotary converters to convert from three-phase to continuous current.

TRANSFORMERS.

A statical transformer is a very simple and efficient apparatus. It consists essentially of two coils, one for the high pressure, and the other for the low pressure, wound on a core of soft iron. An alternating electric pressure is applied to one of the coils, and the resulting current produces waves of magnetic induction in the iron, corresponding in periodicity and within limits of amplitude. These magnetic waves again induce waves of E. M. F. in the other or secondary coil, and of counter E. M. F. in the primary coil. The E. M. F. in each coil is proportional to the number of turns, hence any desired proportion can be obtained. The iron is so shaped that the magnetic induction or flux of force completes its circuit within the iron, and no free poles or external fields are produced, the total induction being thus much greater than it would be if the magnetic circuit had to be completed through air. The iron is also finely laminated to avoid the waste energy and heat which would result from the generation of spurious electric currents within the iron itself.

The losses of energy in a transformer are relatively small. There is no rotating mass involving friction at bearings, but there is a constant loss caused by the changes of magnetization in the iron and probably of the same nature as frictional loss, and a varying loss due to the resistance of the coiled conductors to the currents. The total loss at full load is about 3 to 4 per cent of the energy transformed. Still, even this small proportional loss produces so much heat that in large sizes of transformers it is necessary to resort to artificial means for dissipating it, since the natural ventilation of a transformer is not so good as that of a machine with rotating coils.

ROTARY CONVERTERS.

The rotary converter exemplifies what I have already pointed out, viz., that every kind of current can be obtained from a dynamo machine. It is, in fact, a multipolar continuous current machine having points in the armature winding connected to a set of contact rings so as to admit of continuous connection being made with each point from the outside while the armature is revolving. The number of points corresponds with the number of different phases of currents for which it is intended, and they are spaced at equal distances apart.

The most general arrangement for traction work is a six-phase current derived from a three-phase current by keeping each phase entirely separate in the secondary circuits from the statical transformers. The machine, when connected to the polyphase current supply, must run in synchronism with the frequency as a synchronous motor, and should be started on the continuous current. These machines are highly efficient, but require considerable attention and skill in management.

In some respects the motor generator arrangement in which the alternating and continuous current armatures are separate, is to be preferred to the rotary converter.

ACCUMULATORS.

Where continuous current is used for supply of power to the trains, a battery of accumulator cells is a very useful adjunct to the equipment of the sub-station, especially where the load is of a very intermittent character, as it must be on lines of considerable length, since the frequency of the service, even with electric trains, cannot be such as to give a continuous load at each sub-station.

If no accumulation is provided, it is obvious that each sub-station must be equipped with sufficient power to deal with the maximum possible load, although such a load may not be reached at all during any ordinary day, and the aggregate of machinery in the sub-stations must exceed that at the generating station. All this machinery has to be paid for and maintained, and also has to be run practically unloaded for a considerable portion of each day.

By using an accumulator battery, combined with an automatic "booster," it is possible to supply the traffic requirements of a very intermittent or varying load, and still have a practically uniform load on the converting machinery.

The diagram, Fig. 6, is taken from a paper by Mr. G. A. Grindle, and shows results obtained at the St. Helen's generating station supplying the tramways load.

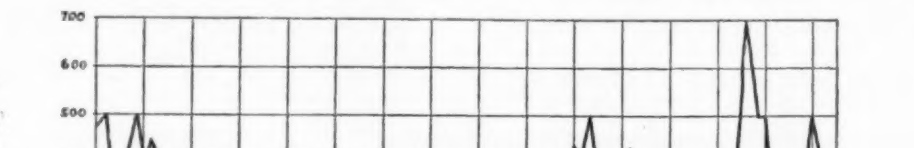


Fig. 6.

Where polyphase currents are used throughout accumulation is at present impracticable, and the transformers in each sub-station must be capable of dealing with the maximum possible load. They are, however, cheap in first cost and maintenance, and their efficiency, even at light loads, is high.

In this case, too, since the supply pressure is so much higher, the sub-stations may be further apart, and, consequently, will have a higher "load factor," as it is called, which means that the average load is larger in proportion to the maximum load than is the case with more frequent sub-stations.

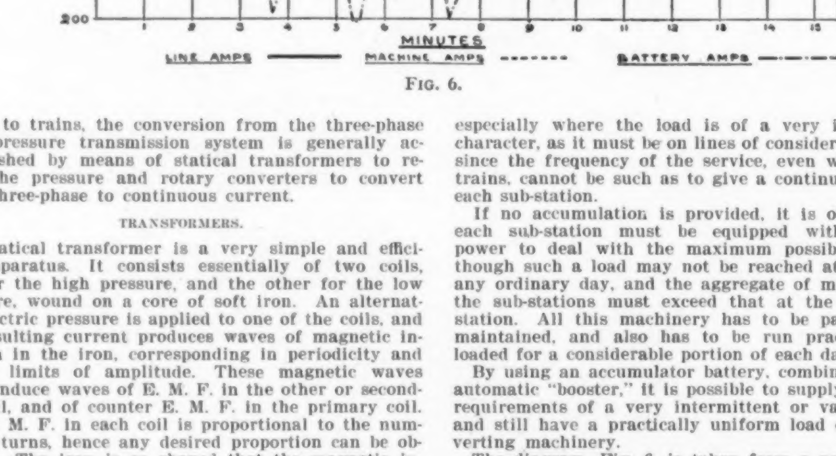


Fig. 7.

SUMMARY OF RELATIVE ADVANTAGES OF CONTINUOUS AND POLYPHASE CURRENT.

Before passing to the discussion of the equipment of a typical railway of the sort which I have indicated as being likely to benefit by electrical working it will be desirable to summarize the relative advantages and disadvantages of the continuous current and the polyphase current systems of traction as they exist to-day for application to full scale railway working.

* Abstract of a lecture delivered before the Society of Arts and published in the Journal of the Society.

To the credit of continuous current must be put:

1. That it is a two-wire system, while the rival is a three-wire system. Every additional contact that has to be made to complete the connection for a running train is a disadvantage, especially at high speeds.

2. That with it accumulators may be used distributed in the various sub-stations, thus reducing the necessary running power both at the sub-stations and at the generating stations to what is required for the mean load, including in this the surplus load required to maintain the batteries properly charged.

3. That there is no "wattless" or idle current with the continuous current as there is with the induction polyphase motors. These idle currents may even be practically eliminated from the high pressure circuit where a high pressure polyphase supply is converted by means of statical transformers and rotary converters to continuous current for traction. In other words, the polyphase system has to provide for about 15 per cent more current than would be necessary for supply of the same electrical power at the same pressure on the continuous current system.

4. That to reduce this idle current very small clearance is necessary between the fixed and revolving parts of the polyphase motor.

5. The variations of speed such as are often required in running can be more easily and efficiently provided with continuous current than with polyphase equipment.

On the other hand, the polyphase system possesses the following advantages, viz.:

1. Great simplification in sub-stations, dispensing with all running machinery, and with one transformation of energy, thus considerably reducing both the capital cost and working expenses, since no attendance is required.

2. Use of pressure as high as 3,000 volts is quite practicable for supply to motors. This increased pressure has the following distinct advantages: That the line conductors may be overhead wires in place of heavy rails, which encumber the permanent way and require to be electrically connected by bonding; that the sub-stations may be placed at greater distances apart, and the power installed reduced proportionately to the better load factor obtained; and that the current required is proportionately reduced, and can be collected with greater ease.

3. The generating plant may be less expensive, as provision has not to be made for running rotary converters.

4. The motors are much simpler, and more mechanical machines. The absence of the commutator, and the low pressure in the rotating portion, tend to diminish the cost of repairs; and the motor may easily be arranged to be entirely supported by springs.

5. The speed of the trains is governed by frequency, which is absolutely constant all over the line, and not by pressure, which is more variable.

The return of energy to the line when stopping or descending grades may also be put to the credit of the polyphase system, as compared with the continuous current system, unless separately excited motors prove practicable. Even without taking this into account, however, I consider that the advantages obtained in regard to means of conversion and from the use of higher pressure sufficient to indicate that the polyphase system is that most suited for use on full scale railways. The picking up of current has been well worked out, and as against the economic advantage of accumulators must be weighed the great expense of installation, maintenance, and attention, the complication of sub-stations, and the increased consumption of energy.

Exactly twenty years ago I read a paper at what was then the Society of Telegraph Engineers suggesting the application of electric motors for driving trains, and pointing out the advantages that would result from the distribution of electric power throughout the train, and from the braking action that could be obtained from the motors. I have seen these anticipations fully realized, and I feel equally confident in prophesying the successful application of the polyphase system to the working of full scale railways.

EQUIPMENT OF FULL SCALE RAILWAY.

In order to give you some idea of the nature and cost of the equipment of a railway of the class which I consider could decidedly use electric traction to advantage, I propose to discuss in some detail the traffic arrangements and equipment of the lines shown in Fig. 7, which, although somewhat analogous to existing lines, is of course not taken from any particular railway system.

The lines consist of two Metropolitan termini, *A* and *B*, from each of which there are four lines of rails to a junction, *C*, about ten miles distant from each terminus. Two of these lines are for local or suburban traffic, forming a loop, *A*, *C*, *B*, with stations about one mile apart. The other two form a junction with each other at *C*, and thence a double line extends to *D*, the town terminal station which we may suppose to be at a fashionable resort, capable of supporting a heavy and continuous passenger traffic with the metropolis. *D* we will take to be 40 miles from *C*, or 50 from *A* or *B*. It is a center of a populous district, and can support a considerable suburban traffic, as indicated by lines *D E*, and *D F*, each about 6 miles long. Further, points, *G* and *H*, about 4 miles from *A* and *B* respectively, are connected by a cross line; *G*, *I*, *H*, *K*, 10 miles from *C* and *L*, 15 miles from *K*, are supposed to be important towns. Intermediate stations are indicated by small circles.

The scheme of traffic during the busy hours of the day is as follows:

1. A suburban service at frequent intervals over *A*, *G*, *I*, *H*, *B*, and reverse.

2. A semi-suburban service, at frequent intervals, over *A*, *G*, *C*, *H*, *B*, and reverse.

3. An express every half hour from *A* or *B* alternately to *D*, and reverse (stopping at *H* and *L*).

4. A service of stopping trains connecting with these expresses.

5. A frequent suburban service over *E*, *D*, *F*, and reverse.

It will be understood that goods traffic will be worked during the hours when the line is not required for passenger traffic. The main generating station I have supposed to be located at *C*, this being a very advantageous position for supplying the two metropolitan termini and intermediate stations. As, however, the suburban traffic at *D* would necessitate the transmission of a large power to a distance of 40 miles from *C*, it is more economical to place a second generating station at *D*, should there be no objection to such an arrangement. The sub-stations are situated as shown on the diagram.

SUBURBAN LINES.

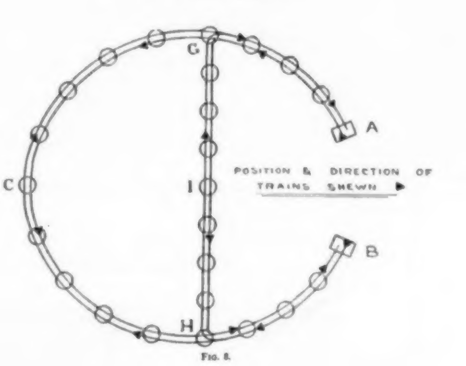


FIG. 8.

Dealing with the suburban traffic between *A* and *B* first (see Fig. 8), a reasonable arrangement would be to run trains at quarter-hour intervals over the line *A*, *G*, *I*, *H*, *B*, and at the same intervals over *A*, *G*, *C*, *H*, *B*. Thus between *A* and *G* and *B* and *H* the trains will be at seven and eight minutes intervals.

Assuming that the traffic varies considerably in amount at different times of day, trains consisting of three motor cars and three trailers, seating, say, 420 persons, would be very suitable for this service, and would weigh, fully loaded, say, 150 tons. At times of minimum traffic one motor and one trailer car can be dropped.

Since the stations are supposed to be at distances apart of only about one mile, the time of running will depend, to a considerable extent, upon the acceleration obtainable, as upon the full speed of the trains.

Full speed must necessarily bear a simple proportion to that of the express trains on the main line. This we may take to be sixty miles per hour with four-pole motors, giving a frequency for the current between 15 and 20 periods per second depending upon the exact diameter of the driving wheels. Then six-pole motors will give a speed of forty miles per hour. Eight-pole motors a speed of thirty miles per hour. A speed of sixty miles per hour is obviously impracticable when the stations are only one mile apart, since full speed could not be attained.

Let us consider a full speed of forty miles per hour. With a mean acceleration of one foot per second, and retardation of 1.5, the train will run

580 yards in 59 seconds accelerating.
380 yards in 39 seconds retarding.
800 yards in 40 seconds full speed.

Allowing twenty-five seconds stop, this gives a time from start to start of 163 seconds, or a schedule speed of one mile in 2 minutes 43 seconds, or for the fifteen miles from *A* to *B* by the route *A*, *G*, *I*, *H*, *B*, 40 minutes 20 seconds, since there are only fourteen stops. Thus the running time for the double journey will be 80 minutes 40 seconds, and the traffic will require six trains, allowing 4 minutes 40 seconds stop at each terminus.

On the other hand, if full speed is thirty miles per hour, with the same acceleration and retardation, the train will run

323 yards in 44 seconds accelerating.
215 yards in 29 seconds retarding.
1,222 yards in 84 seconds full speed.

Or with the same allowance for stop, this gives 182 seconds from start to start. So the train cannot complete the cycle in 90 minutes, or seven trains will be required in place of six trains. If we allow 30 second stops, the 40-mile trains would still have 3 minutes 30 seconds at each terminus.

The power taken during acceleration by the 40-mile train would be about 900 kilowatts, while the 30-mile train, allowing for the saving of weight due to the smaller power required, would only take about 600 kilowatts, and when running at full speed on the level the powers taken would be 200 kilowatts and 115 kilowatts respectively, assuming resistances at 15 pounds and 12 pounds per ton in the two cases.

Since the stations are assumed to be one mile apart, the energy taken per mile in the two cases would be in kilowatt seconds:

For 40-mile train:

Accelerating .... 900 × 59 =	53,100
Running .... 200 × 40 =	8,000
	61,100
Returned in braking, say	7,000
	54,100

Or about 15 Board of Trade units.

For 30-mile train:

Accelerating .... 600 × 44 =	26,000
Running .... 115 × 84 =	9,660
	36,060
Returned	3,060
	33,000

Or about 9 Board of Trade units.

The 40-mile trains do 20 miles per hour, and there are six of them; the total hourly consumption for the service will be, therefore, 1,800 units. The 30-mile trains do the same number of miles per hour, so the total hourly consumption in this case will be 1,080, the difference being 720 units, or at ½d. per unit, 30s. per hour, against the quick service.

The maximum power required will also be greater with the quick than with the slow service, necessitating additional capital expenditure in the generating sub-stations. On the other hand, we have with the slower service the extra capital cost of one train and its proportionate reserve, and the charges of the staff required for this train, not only for running, but for cleaning and looking after it, and that of its maintenance and repair. But the main consideration is the greater popularity of the quicker service. An additional 3d. earned per train mile will pay for the extra consumption, while the capital expense is nearly equal in the two cases.

An argument in favor of deciding for the quick service is, that the exigencies of traffic on the main line will certainly necessitate the use of motors calculated for 40 miles per hour speed, and by adopting the same speed for the suburban trains, the complication of a different pattern of motor and equipment is avoided.

On the whole, the balance of advantage is with the fast trains, if stops averaging 30 seconds can be worked. In America, stops of 20 seconds are found sufficient in similar cases, but we are not quite so "spry" here.

It would of course be quite practicable to run a 10 minutes service of 100-ton trains over the suburban lines without any additional rolling stock, and some saving of power would be thus secured. Probably the service between *E*, *D*, and *F* might be worked by 100-ton trains, consisting of two motor and two trailer cars, at quarter-hour intervals.

We will next consider the main line service. The diagram, Fig. 9, shows the scheme of traffic I would suggest.

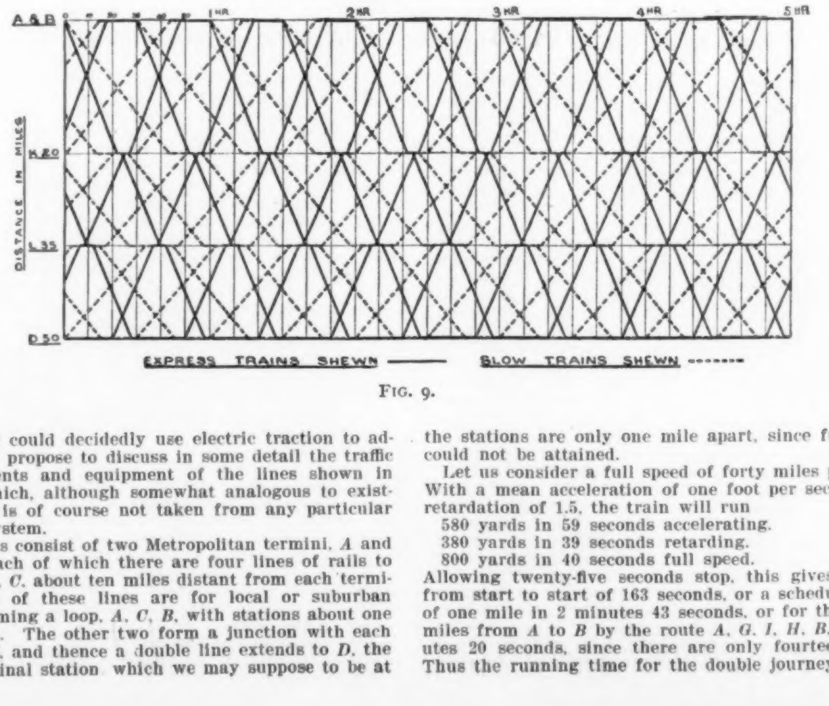


FIG. 9.

The black lines are expresses starting every half-hour alternately from *A* and *B*, stopping only at *K* and *L*, and reaching *D* just under the hour. Stopping at *D* twenty-one minutes they return to *B* and *A* respectively, whence they start again in twelve minutes time.

Thus, a train from *A* takes five hours for a complete cycle to *D*, then to *B*, then to *D* again, and finally to *A* before starting from *A* again, and five trains are required for the service. The normal trains might consist of two motors and two trailer cars, total weight, say, 100 tons.

At the intermediate half-hours a stopping train starts from *A* or *B*, or at the same time that the express starts from *A* the slow train starts from *B* and *vice versa*. This stopping train stops at *G* or *H*, *C*, and all stations from *C* to *K*, doing the 20 miles in about 43 minutes, and arriving at *K* 9 minutes before the express leaving half-hour later, which takes 22 minutes to do the 20 miles. Full speed of stopping train 40 miles per hour. This slow train does not go beyond *K*. It waits there until after the next up express has left, and then returns to the same terminus from which it started, stopping at the same stations. These trains would have two motor cars, one at each end, and three trailer cars, since an acceleration of 0.75 mean will be quite sufficient. Total weight, say, 120 tons.

Four trains are required to work the service. Immediately after the down expresses leave *K* and *L* slow down trains start from these stations to *L* and *D* respectively, returning in each case after the next express so as to reach *K* and *L* well before the succeeding up express, full speed being 40 miles per hour. These will in ordinary times consist of three cars, two being provided with motor equipment together equal to one motor car. Total weight, say, 70 tons. Three trains are required to work the service between *K* and *L*, and the same number between *L* and *D*.

With this service it will be seen that every station on the line has the advantage of a half-hourly service at fixed schedule in both directions, and that to reach a terminus from any intermediate station it is not neces-

sary to travel in a stopping train for a greater distance than something under 15 miles.

The arrangement would, however, be somewhat inconvenient for passengers traveling between intermediate stations passing *K* or *L*, and for their convenience it might be desirable to run a few of the stopping trains through. The time taken would be the same, but passengers would not be obliged to change carriages.

The power taken by the expresses depends upon the steepness of the grades to be encountered since rapid acceleration is not required in this case. We may assume that the steepest grade will not exceed 1 in 100, and in this case the maximum effort will not exceed 600 kilowatts per train of 100 tons, and this will give a mean acceleration on the level of 2-3 foot per second. The power taken at full speed on the level will be about 300 kilowatts.

The maximum power taken by the 120-ton slow train from *A* or *B* to *K* accelerating at 0.75 mean on the level will be 550 kilowatts, and for running on the level 160 kilowatts, and that taken by the slow trains weighing 70 tons between *K M* and *D* will be 285 kilowatts, the mean acceleration being 0.66, and for running on the level 95 kilowatts.

With the proposed arrangements therefore two motor equipments will be necessary, one for the express service with 4-pole motors, and one for the slow service with 6-pole motors. Each motor bogey truck would be fitted with two motors, one primary and one secondary, the primary motors being capable of taking a load of 150 kilowatts for short periods.

It would not be desirable to provide different equipments for the varying requirements of the slow trains, since a power represented by 300 kilowatts per motor car will satisfy all requirements. In the case of the 70-ton trains, however, one bogey truck at each end of the train would be fitted with motors.

We can now assess the maximum demand for electrical energy on the various sub-stations as indicated in the diagram. Taking Station *A*, the maximum output occurs when a main line train taking 600 kilowatts synchronizes in starting with a local train taking 900 kilowatts. At this time, the next local train on the down line, starting, say, seven minutes earlier, should be midway between the second and third station from *A*, running at full speed, taking, say, 200 kilowatts, also a local train on up line leaving for *A* having just finished accelerating. If at all delayed, this train might be taking 900 kilowatts. The next local trains will be the other side of *G*. The incoming main line train should be six miles off at this time, or well the other side of *G*. Since *A* will not have to provide all the power for the trains intermediate between it and *G*, an allowance of 2,500 kilowatts in transformers appears sufficient; *B* of course requires the same equipment; *G* and *H* may possibly have to accelerate two local trains and a main line train, and provide some power for an express running, so that the same power will be required; *I* has nothing to do with the main line, and 1,500 kilowatts will be quite sufficient; *C* should have the same power as *G* or *H*; *K* has its maximum load when an up-local train starts; two expresses and three other local trains being then partly supplied from this station, 1,500 kilowatts will suffice for this.

The other two intermediate sub-stations divide the starting load of the expresses at *L*, and as at these times the nearest local trains are well away from them, an equipment of 1,000 kilowatts each should be sufficient if there are no severe grades.

The sub-station at *D* must be able to start an express and carry on the local traffic simultaneously, and assist in running another express. Total power, say, 3,000 kilowatts.

The next estimate is that of the power required to be delivered by the generating stations at *C* and *D* respectively. Station *C* has to provide for all local service on the two routes between *A* and *B*. These services require, as we have seen, fourteen trains, and it will be safe to take it that at any one time seven of these may be accelerating, four running, and three stopping or at rest at stations. It also has to provide for the main line requirements as far as sub-station *K*, and all power supplied from it. The maximum call is when an express is starting from *A* or *B*.

At this time the station has to provide for—say, 1½ expresses running at full speed, two 120-ton stopping trains accelerating, two 120-ton stopping trains running, and say, 300 kilowatts for light stopping trains.

The power taken by these trains will be as follows:

7 local trains accelerating	=	6,300 kilowatts.
4 local trains running	=	800 kilowatts.
1 express accelerating	=	600 kilowatts.
1½ express running	=	450 kilowatts.
2 stopping trains accelerating	=	1,100 kilowatts.
2 stopping trains running	=	320 kilowatts.
Add for light trains	=	300 kilowatts.
Add for light grades	=	300 kilowatts.
		10,170 kilowatts.

We have now to allow say 15 per cent for line and transformer losses, making a maximum effort from the station of 11,700 kilowatts.

With proper allowance for spare, six sets of 3,000 kilowatts each will be a suitable equipment.

For station *D* we require to provide for the local traffic five trains, one express accelerating, 1½ at full speed, and four stopping trains. A total power of 4,000 kilowatts running will be sufficient, or say six sets, of 1,000 kilowatts each.

It should be noted that it will not be necessary to put down boiler capacity for this power running continuously, since the mean load will be only about one-half of the maximum effort.

The overhead wire equipment would be the largest size of trolley wire in use, No. 0000 S. W. gage, erected on supports at intervals of about 88 feet, and properly guarded so as to prevent any risk from a broken wire remaining charged. The third conductor would be preferably formed by a flat copper strip of twice the sectional area of the trolley wire, supported at the side of the track on fairly insulating supports. The maximum drop on the line will be 130 volts, or 64 volts on the strip. This gives under 8 per cent loss.

The 12,000-volt mains would be arranged so that a breakdown in any one cable will not stop the supply to any sub-station. This, however, only necessitates one cable between *K* and *D*, since the intermediate sub-stations can on emergency be supplied from *C*, and this will provide for shutting down the station at *D* and undertaking the whole supply from *C* during periods of light loads. It would probably be found preferable to keep the two stations quite distinct and not to attempt synchronizing.

The loss in these mains should not exceed about 3½ per cent unless the transformers at the sub-stations are specially wound to compensate for the loss, and this limit can be worked to without undue cost.

The exact cost of the equipment I have sketched would, of course, depend upon many conditions, which would differ in different cases, but at present prices the amounts would be somewhat as follows:

Generating stations, complete	£400,000
Sub-stations and equipment	62,000
Mains	160,000
Line equipment	228,000
	£850,000

The expense of the rolling stock which would be required would naturally depend upon how much of the existing stock it was proposed to retain. The cost of a complete equipment to run the traffic as given above would be probably about £424,000.

THE MANOGRAPH.

THE use of motors of high angular velocity has been greatly developed by the automobile, and the present experiments with alcohol as a motive power can but still further multiply their applications. All the thermic motors of the explosion or internal combustion type are based upon the four period cycle of Beau de Rochas—suction of the mixture, compression, ignition and exhaust. In order to obtain the greatest quantity of work possible in the cycle, it is necessary properly to proportion the richness of the explosive mixture, the capacity of the explosion chamber, the stroke and diameter of the piston, the instant, intensity and rapidity of the sparking, and the proportions of the exhaust, in order to reduce the counter-pressure, the lifting of the valve, etc.

All these factors are intimately connected with each other, and it is generally impossible to act upon one of them without more or less modifying the action of all the others in a manner favorable or unfavorable to the end that we have in view. The exact relation of all these factors to each other can therefore be ascertained only through lengthy, manifold and expensive experiments of which the simplicity of the present motors can give no idea. The researches would be facilitated, the study rendered more methodical and further progress would be made were it possible to know at every instant what is taking place in the cylinder during four periods of the cycle, and if, in a word, we had for motors of which the angular velocity varies between 1,000 and 2,400 revolutions a minute an indicator analogous to that which Watt devised more than a century ago for steam engines.

The problem was presented in a particularly urgent manner at the recent competition of alcohol motors organized by the French Minister of Agriculture. The majority of the apparatus exhibited were gasoline ones modified with more or less skill with a view to the utilization of the new carburant. It was for the purpose of solving this problem that MM. E. Hospitalier and J. Carpentier, two well-known engineers, collaborated, with a view to the production of an optical indicator. The principles upon which this apparatus, called the "Manograph," are based are all well known, and the idea of utilizing a luminous ray as an index without inertia in view of this special application, either by means of two mirrors or by a single one, was materialized in 1891 by Mr. John Perry, former president of the Institution of Electrical Engineers. But the Perry apparatus could be used only for velocities not exceeding 500 or 600 revolutions a minute, and its arrangements did not permit of its being mounted upon a motor exposed to vibrations as strong as those to which explosion motors are sometimes submitted, especially when they are imperfectly balanced.

In the manograph, the apparatus is completely separated from the motor, and is connected with it by a flexible tube, *A*, designed to transmit the pressures to a flexible shaft, *B*, which transmits the rotary motion of the shaft of the motor to the apparatus.

The principle of the apparatus is exceedingly simple. Let us consider a small mirror resting upon three points arranged at the three summits of a rectangular triangle. The point resting upon the apex of the right angle is fixed in space; one of the two other points displaces itself at right angles with the plane of the mirror proportionally to the pressures; and the third, proportionally to the stroke of the piston. Under such circumstances, the small mirror, under the influence of a spring that holds it permanently upon the three points, takes inclinations such that, if a luminous ray be projected upon it, the displacements of the reflected part will trace a diagram upon a ground glass placed at a proper distance. The persistence of the impressions upon the retina will cause the diagram to appear in the form of a continuous line, which we shall be able to examine at leisure, make a pencil drawing of upon tracing paper, or take a photograph of.

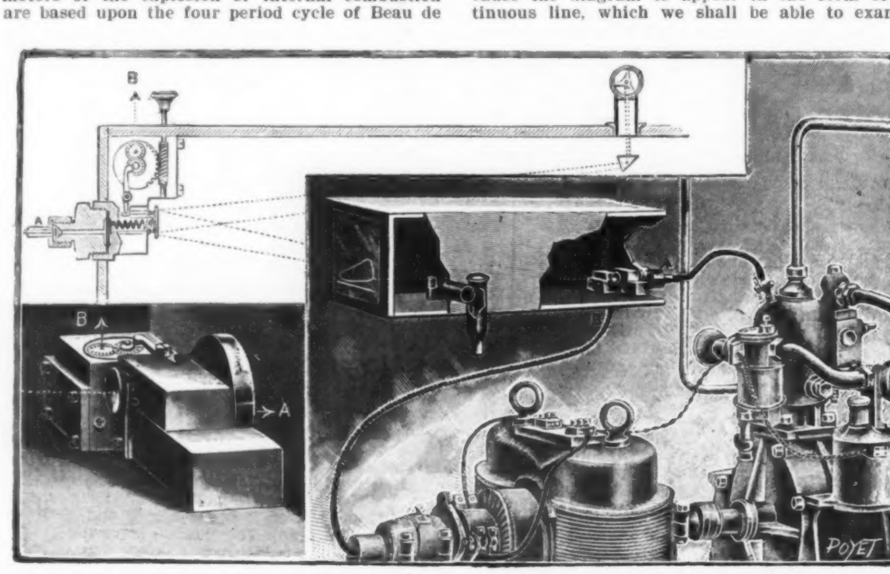


FIG. 1.—GENERAL VIEW OF THE MANOGRAPH MOUNTED UPON A GROUP OF DE DION AND BOUTON ELECTRIC GENERATORS; WITH DIAGRAMMATIC PLAN AND DETAILS OF THE APPARATUS.

Retardation of sparking. Normal sparking. Advance of sparking.

FIG. 2.—DIAGRAMS TAKEN PHOTOGRAPHICALLY UPON A GASOLINE MOTOR.

In the model that operated at the International Exposition of Automobiles, and which is represented in Fig. 1, mounted upon a group of De Dion and Bouton generators of electricity, the luminous pencil is produced by a small flame of acetylene. A total reflection prism sends the luminous pencil to the mirror, which reflects it to a screen so constructed as to give diagrams 5 inches in length by from 3.5 to 4 in height. It is unnecessary to say that, by modifying the focal distance of the mirror, the distance of the screen and the intensity of the luminous source, it would be possible to obtain diagrams of any dimensions whatever and to make projections thereof on a large scale for the purpose of instruction, for example.

It now remains to explain how the motions are respectively transmitted to the two points that displace themselves proportionally to the pressure on the one hand and the stroke of the piston on the other.

For the pressure, a rod bearing against the mirror by one of its extremities rests, through its other, upon an elastic disk fixed by its periphery to a chamber communicating with the top of the cylinder through a copper tube about 0.04 of an inch in internal diameter. Under the influence of the variations in pressure produced in the cylinder during the four-period cycle, the disk actuates, more or less forcibly, the rod upon which the mirror rests. In this way, displacements sensibly proportional to the pressure are obtained. It is easy, moreover, through a previous graduation of the disk, to reconstruct, when necessary, an exact diagram of the planimeter.

For the motion of the piston, a second rod receives

a reciprocating motion, synchronous with that of the piston, through the intermedium of the flexible shaft, and of a repeater consisting of a combination of a crank and connecting rod of reduced dimensions. Since the synchronous motion might be produced with a certain retardation or advance between the motion of the piston and that of the connecting rod, the motion of the flexible shaft is transmitted through a train of gearings, the wheels of which are provided with the same number of teeth. The axis of the flexible shaft is capable of displacing itself around the axis of the crank, and such displacement is controlled by a regulating screw placed externally upon the box. Under such circumstances it is possible, by displacing the axis of the flexible shaft at a proper angle, to obtain both a synchronism and coincidence of the phases of the motion of the piston and of that of the rod that forms the abscisses.

It will be seen from this description that the masses set in motion are very small and the displacements and velocities very feeble, and that no perturbating thrust is to be apprehended, even, as experiment has proved, when the motor is making 2,200 revolutions a minute.

In Fig. 1 the mechanism of which the principle has just been indicated is shown. Fig. 2 gives a reproduction, on a reduced scale, of a characteristic diagram of a gasoline motor operating under typical conditions of sparking. An examination of these diagrams brings clearly into relief the important modifications that this factor introduces into the form of the diagram and the distribution of the pressures during the cycle.

The manograph furnishes inventors and manufacturers with a most valuable and useful apparatus for research; and it makes its advent most opportunely at a time when a contest is beginning between gasoline and alcohol upon the ground of their applications to motive power.—For the above particulars and the illustrations we are indebted to La Nature.

PRESS FOR COPPER-BANDING SHELLS.

PROJECTILES for guns are fitted nowadays, as most of our readers are aware, with a copper driving band. This is a copper strip of a width varying with the size of the projectile, rolled or pressed into a groove made for its reception near the base of the shell. It is slightly tapered or beveled toward the front, so that it may be driven by the gas pressure into the rifling. It serves a double purpose. By engaging with the rifling of the gun it gives rotation to the projectile, and at the same time by its expansion into the bore

FIG. 2.—PLAN OF PRESS.

it acts as a gas check and reduces the erosion of the gun by minimizing the escape of gas round the shell.

From these introductory remarks it will be seen that the following are the essential features of a properly fixed band: (1) it must be pressed so firmly on the shell that every portion of it is home in the groove, completely filling the undercuts, and so that the serrated projecting vees on the shell arranged to prevent the ring rotating without the projectile, are firmly embedded in the copper. (2) All the portions of the band should be equally compressed, so as to possess the same degree of density. (3) While the band must be pressed on with sufficient power to fulfill condition (1), the shell itself must not be upset enough to prevent the easy insertion of the screw gage in the fuse seat in the base of the shell.

The usual methods of forcing the bands into the grooves are either the use of a pair of semicircular dies, brought together by a hydraulic ram, or forcing the shell through a conical die. The former method has the disadvantage of not compressing the band equally throughout its circumference; while the latter method has a tendency to cause the copper to flow toward the rear of the shell. Another objection to the use of the conical die is that the least variation in the thickness of the rough copper band has a corresponding effect on the degree of tightness with which the compressed band grips the shell.

In the press under notice the makers claim that the above disadvantages are conspicuous by their absence, and as this type of press is used at the shell factories, Woolwich, it would appear that the process was an advance in the right direction.

The system employed is that commonly known as "West's Patent System," in which a quantity of rams are arranged circumferentially on a bed-plate, and capable of traveling toward a common center, and the principle of the shell-banding presses will be readily understood from the photographs and drawings shown. One view is from a photograph of a press designed for John Rogerson & Co., of Wolsingham, and made by the West Hydraulic Engineering Company, 23 College Hill, London, E. C. Shells from 4.7-inch to 12-inch caliber can be banded in this press. Fig. 2 is a plan, and Fig. 1 shows a half section taken through the center of one of the cylinders, and the following is a brief description of this size of press:

A is a strong cast iron bed plate, circular in form, supporting a weldless rolled nickel steel ring, *B*, 9 inches deep and 8 inches broad; to the inner circumference of this ring are fixed eight steel cylinders, *C*, 15 inches in diameter, with S. M. steel rams, *D*, guided by means of a smaller ring, *E*, and carrying on their ends removable die blocks, curved to suit the periphery of the copper band. Pressure is conveyed to the cylinder by means of radial pipes, *H*, communicating with a common distributing chamber, *K*. The rams are all single-acting, and their return is effected by the springs shown, one of which is placed under each ram.

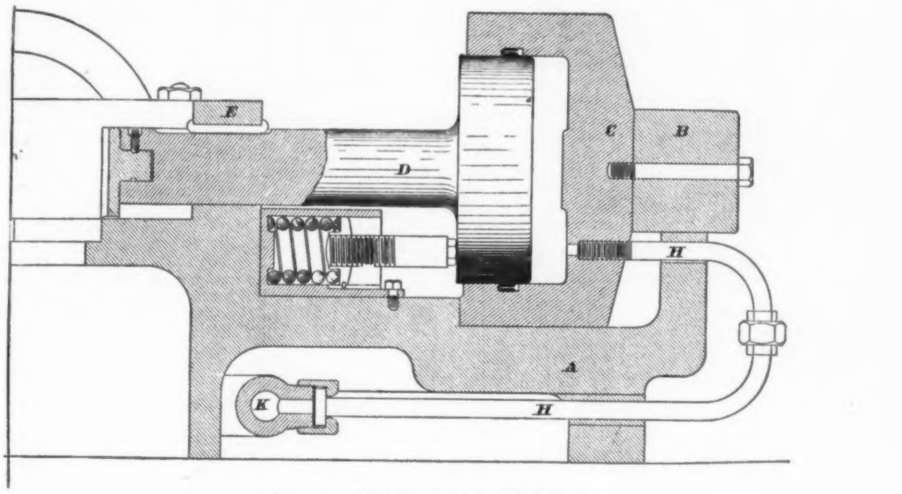
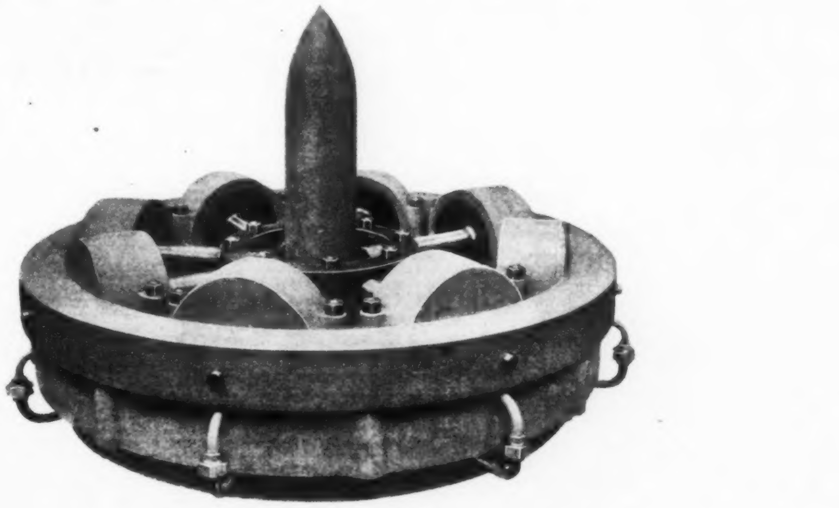


FIG. 1.—SECTION OF PRESS.

Pressure is supplied by means of a two-throw belt-driven pump, working up to 4,500 pounds per square inch when pressing the largest sized bands, but in some cases the makers supply a small intensifier instead of the pump, so as to utilize existing hydraulic pressure mains. The weight of the press in question is 12 tons. The copper rings are, of course, turned accurately to size after they are pressed on.—The Engineer.



SHELL-BANDING MACHINE.

HOW DYNAMITE IS MADE.

ORDINARILY dynamite can be kicked about the floor, dropped from a height, wrecked in a railroad train, set on fire and burned, all without danger. But careless handling is certain to result in catastrophe, simply because dynamite is an explosive. The factor of danger in handling dynamite increases with the increasing temperature of the commodity. It freezes at 34 deg. In that condition it is absolutely safe and cannot be made to explode; in other words, it becomes a non-explosive. At 340 deg. dynamite will explode spontaneously. Between the freezing point, therefore, and the exploding point the factor of danger increases in proportion to the rise in the temperature by which the dynamite is affected.

There are eight large dynamite factories in this country, three of which are on the Pacific coast, about thirty miles from San Francisco, one in Missouri, one in Michigan and three in New Jersey. About one thousand persons are engaged in the work at the factories, and about fifty million pounds a year are turned out and shipped by rail, by boat and by wagon all over the country.

The basis of dynamite is nitro-glycerine, which is usually manufactured in the same plant as the dynamite. Nitro-glycerine is made by mixing two parts of strong sulphuric acid with one part of strong nitric acid. After the liquid has been thoroughly mixed it is cooled by being placed in a vessel around the sides of which run metal coils of pipe, through which flows cool water or cold air from a refrigerating plant. The proper proportion of mixed acid is now put into thi vessel, the whole is agitated by means either of a mechanical mixer or by having air forced through it, and highly concentrated glycerine is added slowly. The temperature of the mixture must not exceed 75 deg., because heat greater than this would cause yellow fumes to arise, and the substance would decompose. A temperature of 300 deg. would cause the liquid to explode in the agitator. After the glycerine has been introduced and the whole sufficiently agitated, the mixture is run into a separate vessel and allowed to stand until the glycerine, now fully charged with the nitric acid, has risen to the surface. This is nitro-glycerine. It is drawn off and washed thoroughly in water, to remove every trace of the sulphuric acid. This is done in an agitator. By a chemical process the acids are reconcentrated, and can be used again and again.

For facility in handling, the nitro-glycerine is then made into dynamite by mixing it with some combustible matter. This consists of nitrate of soda or nitrate of potash and a proper proportion of carbon. The carbon considered the best for this purpose is fine wood-pulp, which absorbs the nitro-glycerine. The absorbent of the nitro-glycerine is known in the trade as "dope," and filling this is the part of the manufacture in which the most care and skill are necessary. The absorption of the nitro-glycerine by the "dope" must be perfect, and the latter must not be surcharged so as to permit leakage. The consequences of dynamite cartridges leaking drops of such a high explosive as nitro-glycerine might be disastrous.

The percentage of nitro-glycerine used in dynamite cartridges varies from 20 per cent to 75 per cent. Of course, the higher the percentage of nitro-glycerine, the higher the explosive power. Ordinarily 40 per cent of nitro-glycerine is used in the manufacture of dynamite. Indeed, more than half of the dynamite made has this proportion. The higher grades are used in mines, and vary in intensity according to the hardness of the rock that is to be removed and the size of the vein that is being worked. In excavating the rapid transit tunnel and other similar work it is usual to employ 40 per cent nitro-glycerine.

When the fine wood pulp and other ingredients are prepared they are placed in a receptacle and the nitro-glycerine is poured in, the whole mass being slowly and thoroughly stirred by mechanical mixers. Great care is taken in this work. In none of the many separated buildings that are used in the manufacture of the high explosive is iron or steel used. The mixers and all other appliances that are connected with the manufacture are of lead, so that there is no possibility of a spark or a sudden and harsh jar being produced. When the component parts have been thoroughly mixed the substance is commercial dynamite. It is then put in cartridge form, being wrapped in two thicknesses of Manila paper, closed at the ends.

Each operation is conducted in a separate building, and the smallest number of workmen consistent with the ready production of the compound is employed. Each man has his own particular work, and none other is allowed under any circumstances to usurp his position. This leads to special education of the employés, and permits the selection of the most intelligent. A single

slip or the least exhibition of carelessness or lack of comprehension of the importance of the greatest care is equivalent to a resignation, and is acted on at once.

Made into cartridges, the dynamite is ready for the market. It is stored in a magazine, which is as far as possible removed from the next building, after having been packed in boxes, usually containing fifty pounds each. The cartridges are from ¾ of an inch to 2 inches thick, and from 4 to 8 inches long. The standard size is 1¼ inches by 8 inches, and is made of 40 per cent nitro-glycerine.

Shipment is made on vessels, cars and wagons, and an explosion, it is said, never occurs unless the detonating caps are with the dynamite. The manufacturers do not ship the caps and the dynamite together, preferring to send them in separate conveyances and at different times, so that by no possibility can they be brought together in transit.

Much has been said since the recent disaster in this city about the danger of carting dynamite through the streets of New York to the various storage places along the tunnel. By no possibility, according to tests that have been made, it is asserted, could any danger arise from this. In the New York office of one of the largest dynamite manufacturing concerns is a photograph of a train wreck which occurred on the Rome, Watertown and Ogdensburg Railroad near Potsdam, N. Y., on July 3, 1897. In one of the cars that was thrown off the track and torn almost to pieces were 10,000 pounds of dynamite. The wrecked car lay with its side broken and the dynamite boxes exposed, but there was no explosion.

The reason why dynamite can be handled without excessive danger to the handler, so the manufacturers say, is because the absorbent that takes up the nitro-glycerine, which is the potent factor, is elastic. The object of using kieselguhr when dynamite was invented was primarily to make the transportation of nitro-glycerine, which up to that time was extremely dangerous because of lack of facility in packing, comparatively safe. Soon it was found that there was not sufficient elasticity in this earth, and experiments were made to find a more elastic substance. Wood fiber was finally selected as the best, because it is light in weight and comparatively elastic.

The largest number of accidents with dynamite occur in the spring and in the fall. The dynamite freezes through the night when the weather is cold, and the men will not take the proper precautions in thawing it out. When you remember that it will explode spontaneously at 340 deg., what can one think of a man who will put it in front of a fire and let it stay there, or in an oven and leave it? There is only one proper way to thaw out dynamite. Put it in a room where the temperature is about 70 deg., and keep it away from the fire. Let it remain there until it has thawed out, and there will not be an explosion until the cap is placed and fired.

Dynamite is dangerous. There is enough trouble now without telling people to let down such safeguards as are maintained. Any explosive is dangerous if it is handled improperly. Dynamite will burn like a candle, only much faster, and without danger. This is because the flames eat up the stuff so quickly that the heat of them does not communicate itself to the unconsumed portion of the stick. But that is no reason why it should be tried by inexperienced persons, nor why the explosive should be set before a fire to thaw out.—New York Tribune.

MATHIAS BALDWIN AND THE AMERICAN LOCOMOTIVE.

On February 27 the management of the Baldwin Locomotive Works of Philadelphia celebrated the seventieth anniversary of their existence as an industry and the completion of the twenty-thousandth locomotive turned out by them. A brief review of the steps by which the modern locomotive has been evolved from the primitive type of traction engine which this country inherited from Great Britain will therefore be of interest. As a history of the Baldwin Locomotive Works is in the best sense a history of the American locomotive, to follow the steps of their development from small beginnings to their present controlling importance will serve the purpose of this sketch.

The Baldwin Locomotive Works began with the inception of railroading on this side of the Atlantic. Their founder, Mathias W. Baldwin, was a jeweler, but saw better opportunities for profit in the manufacture of bookbinders' tools and cylinders for calico printing. This led him to design an engine for the power required in running his machine shop, and his first upright engine was so successful that it brought him many orders and gradually changed the character of his business from special lines to general engineering. It is interesting that Baldwin's engine, built in 1830, is still preserved intact. It supplied power for six departments of the locomotive plant as they were successively opened, and is still in good order.

About this time the use of steam as a motive power for long-distance transportation had begun to attract the attention of American engineers. Some locomotives had been imported from England and one had been built at the West Point Foundry, in New York, which was not altogether successful for the purpose for which it was designed. As a locomotive was then a matter of great public interest and curiosity, Franklin Peale, of the Philadelphia Museum, applied to Mr. Baldwin, as a skilled mechanician, to construct a miniature locomotive for exhibition. The result of this order was a locomotive capable of drawing two cars with seats for four passengers, which was set to work on a circular wooden track shod with hoop iron in Peale's Museum, and attracted much notice. This called attention to Mr. Baldwin as an ingenious and clever mechanic, and brought him an order from the Philadelphia, Germantown & Norristown Railroad for a locomotive, to replace horses for car traction. His only guide in design was an examination of the parts of an English locomotive imported some time before by the Camden & Amboy Railroad, but not used up to that time, and his experience in building the model for Peale's Museum. The difficulties encountered in this work were very serious. There were no machine tools available, and the cylinders had to be turned by means of chisels fixed in blocks of wood and revolved by hand. For the reason that mechanics capable of doing the work required were not to be had, Mr. Baldwin was under the necessity of doing most of the work himself, of educating the workmen he needed to employ and of devising most of the tools for his several operations. It is calculated to impress the reader with the suddenness of mechanical development, that all this is easily within the memory of living men.

Baldwin's first practical locomotive was finished and tested November 23, 1832. It was named "Old Ironsides," and was successful. Of course it had some defects, which were afterward remedied, but it was put immediately to work and continued in service for over twenty years. It was a four-wheeled engine, weighing 5 tons. The cylinders were 9½ inches diameter, and the stroke 18 inches. The frame was of wood, built outside the driving wheels, which had cast iron hubs, wooden spokes and rims and wrought iron tires. The boiler was 31 inches in diameter and contained 72 copper flues 7 feet long and 1½ inches diameter. The valve motion was given by a single loose eccentric for each cylinder, placed on the axle between the crank and the hub of the wheel. The engine was reversed by changing the position of the eccentric on the axle by a lever operated from the foot board. The cylinders exhausted against each other. This was found objectionable and was subsequently remedied by turning the exhaust pipe of each cylinder separately into the stack, substantially as is now done. The steam joints were made with canvas and red lead, after the English practice. For this engine Mr. Baldwin received payment on a compromise of his claim, accepting $3,500. It did not fully conform to specifications, but was a remarkably good guess on the part of its ingenious builder. It was run in good weather in the regular service between Philadelphia and Germantown. In bad weather horses were used. Trials showed it capable of drawing its train at a speed of 30 miles an hour, but it was too light for the grades.

This experience brought Mr. Baldwin to the front as a locomotive builder, practically the first in this country, and his work attracted much attention from those capable of appreciating the possibilities of steam transportation. He built an engine for the Charleston & Hamburg Railroad in 1834, which was a remarkable achievement, all things considered, and showed many improvements on Stephenson's engine, built for the Mohawk & Hudson Railroad. The boiler had a high dome over the firebox and established a type which was closely followed for many years. In the same year he built a locomotive for the State road, operating a line from Philadelphia to Columbia, which was so successful that the Legislature decided to operate the road wholly by steam power. This conclusion was vindicated by the performance of Baldwin's engine in drawing 19 loaded freight cars over the steepest grades of the road. Five locomotives were built in 1834, and the business which began with the building of a model for a museum was fairly started. More room being needed, the works removed to their present location in 1835.

Baldwin was a very capable engineer and had the valuable quality of learning wisdom from experience. Every locomotive he built was better than its predecessor, and he made many valuable inventions which are the basis of modern locomotive practice. Fourteen engines were built in 1835, forty in 1836, the same number in 1837, twenty-three in 1838, twenty-six in 1839, and nine in 1840. In common with most men in active business, Baldwin came to grief during the financial troubles of 1838-40, and began to feel the effects of competition. However, he weathered the storm, and when business activity was resumed was in better position to take advantage of it than any one else, as his intimate study of every detail of locomotive building had given him a valuable patent protection. From 1842 the business experienced a steady development, which identified it with the most memorable period of our national history. To follow the details of Baldwin's work in the improvement of locomotive engines would be impossible. In the early days of railroading wood was the fuel employed, and the wood-burning type of engine continued in use until 1847, when the Baltimore & Ohio Railroad ordered four engines to burn Cumberland coal. Baldwin took the order and the engines were satisfactory.

The art of locomotive building was indebted to Mr. Baldwin for so many features of value that it would be difficult to designate those of most importance; but perhaps the greatest and most permanent value resides in the practice first introduced by him in the employment of a system of standard gages and templets. The importance of this system in securing absolute uniformity of essential parts of all engines of the same class is obvious, and without it the increased production of the works since 1861 would have been practically impossible. He also gave his best efforts to establish in practice the principle that all parts of similar engines should be absolutely uniform and interchangeable. At the present time an important department of the Baldwin Locomotive Works, having an organization of its own and a special equipment of tools and a staff of skilled workmen, is that of standard gages. It insures an absolute uniformity and interchangeability of parts in engines of the same class, permitting an output otherwise impossible, and minimizing the cost of repairs to the customer, as well as saving a great deal of time in duplicating parts. Frames are planed and slotted to gage and drilled to templet. Cylinders are bored and planed, and steam ports, with valves and steam chests, are finished and fitted to gage. By the same method tires are bored, centers turned, axles finished, cross heads, guides, guide bearers, pistons, connecting rods, etc., planed, slotted or finished. Every bolt in an engine is made to a gage, and every hole is drilled and reamed to a templet. Only exact duplicates of the standards go to the shops, consequently there is no variation due to wear. The perfection of this system is a monument to the mechanical skill and foresight of Mathias Baldwin, who died in 1866, of venerable age and crowned with honors as one of the greatest of American mechanics. Beginning with "Old Ironsides" in 1831, thirty years were covered in the building of the first thousand locomotives turned out by the Baldwin plant. Since 1861, 19,000 have been built. This fact is significant when it is remembered that with the outbreak of the civil war it was deemed improbable that any further expansion of the railroad industry would take place.—Iron Age.

COMMERCIAL RESOURCES OF TIERRA DEL FUEGO.

The archipelago of Tierra del Fuego is usually represented as a desolate, unproductive country, yet the principal islands possess dense forests, and most of them have numerous streams of water. The territory of Magellanes, which belongs to Chili, is, according to the latest reports, especially destined to become prosperous. Sheep rearing, and the exploitation of building woods and of petroleum wells are among its sources of wealth. Magnetic iron abounds, and coal, although of mediocre quality, is found on the Atlantic coast and on the Straits. Punta Arenas, the capital, owes its rapid development to sheep rearing and gold washing. The sheep of this region appear to be native to it; the wool is longer, more silky and tougher than the Argentine wool, and is not greasy. It is said to find a ready sale in English markets. There is no sickness among the sheep. The chief exports are gold, in dust and nuggets, wool, ostrich feathers, skins of llamas and of seals, live sheep, frozen mutton, and tallow. In the last five years, three concessions on the south coast of the Strait have been made to English societies. On the north coast of the Strait are some very prosperous French concessions. The only Argentine establishment is at the southern extremity of the archipelago. The island of Hoste, which is very mountainous, has a colony established by an English mission; the washing of the auriferous sands here has given good results. Punta Arenas is a free port. Merchants, especially from Argentina, flock there, exchanging their manufactured articles, almost at the European price, for skins, gold and building wood. The Chilian government keeps a small squadron of steamers to police the canal, protect the shipwrecked, and prevent gold washing or seal killing by unauthorized persons.—Journal of the Society of Arts.

DE BECHI'S IMPROVEMENT IN THE TREATMENT OF TIN ORES.

In the process of M. De Bechi, the ore is prepared for a further treatment by submitting it to an oxidizing roasting, alone or mixed with pyrites, or with sea salt, or with a mixture of the two, according to the nature and the composition of the ore.

During the roasting, the greater portion of the antimony is volatilized in the condition of a chloride or an oxide, which can be collected in the condensation towers.

The roasted ore contains lead in the state of sulphate and oxide, a small quantity of antimony in the state of oxide, and tin in the form of stannic acid. The tin can be easily separated from the mixture, its oxide being endowed with acid properties, while the oxides of lead and antimony are basic.

The roasted ore is heated with the quantity of chlorhydric acid necessary to dissolve antimony. This acid may be obtained by the condensation of the fumes set free during the roasting. The residue of lixiviation is treated with caustic soda, which combines with stannic acid so as to form sodium stannate, easy to isolate on account of its solubility in water. The residue contains lead, silver, gold and iron, the last named being obtained from the ore itself, as well as from the pyrites, which was added at the time of roasting. This residue treated by the usual methods in an appropriate furnace yields lead mingled with all the precious metals contained in the ore.

The solution of sodium stannate can be treated in various ways; for example by adding to the heated solution enough milk of lime to form an insoluble calcium stannate and thus to recover the caustic soda; or by passing a current of carbonic acid gas through the stannate solution in order to precipitate the stannic acid with the formation of sodium carbonate, which, treated with milk of lime, recovers the caustic soda. In this way the soda continually re-enters the operation. It is sufficient to add some of it from time to time to repair loss. This loss does not exceed 10 to 15 per cent of the quantity requisite to convert the stannic acid into sodium stannate.

The stannate of lime or the stannic acid obtained by this process can be converted by the usual processes in to other compounds of tin of commercial value or into metallic tin.—Translated from La Revue des Produits Chimiques.

ARGON AND KINDRED ELEMENTS.

Prof. William Ramsay, the discoverer of several new elements in the atmosphere, recently made public additional facts concerning them. It should be premised that Lord Rayleigh was associated with him in the finding of argon, the first in historical order, says the New York Tribune. Another, helium, was long known to be present in the sun, and the earliest terrestrial observation of it was the mineral known as cleveite. It has since been recognized in the air, also. Prof. Ramsay believed that he found traces of four more elements, which he named metargon, neon, krypton and xenon. He cannot confirm the discovery of metargon, however, and now drops it from his list.

Mendeleff found that when he arranged the different chemical elements in groups, on the principle of similarity in qualities, a mathematical relation existed between the atomic weights of the members of each series, although the ratios are not exact. These, for instance, are the figures for one group: Fluorine, 19; chlorine, 35.5; bromine, 80, and iodine, 127. Here is another series: Lithium, 7; sodium, 23; potassium, 39; rubidium, 85; and cæsium, 133. When argon was discovered, it was impossible to place it in the table. After finding helium, though, Prof. Ramsay was satisfied that he had started a new group. He is more convinced than ever now, having identified three more elements, and having ascertained their atomic weights. He arranges these as follows: Helium, 4; neon, 20; argon, 40; krypton, 82, and xenon, 128. All five,

moreover, possess this trait in common: they show a peculiar reluctance to form chemical combinations.

Of course, these elements exist in the air in minute proportions. Otherwise they would have been discovered before. Prof. Ramsay recently announced that the atmosphere contains 0.937 part in 100, or a little less than 1 per cent of argon, one or two parts of neon in 100,000, one or two parts of helium in 1,000,000, about one part of krypton in 1,000,000, and about one of xenon in 20,000,000. The proportion of gold sometimes found in sea water is one part in 15,800,000.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Opening for Coal in Germany.—The stagnation of business in Germany during the last year has affected nearly all branches of industry and has also had a marked influence upon coal prices. Yet the reduction in coal prices has not been as important as had been anticipated. The mine syndicates have succeeded by artificial means—such as reduction of outputs and of wages—in maintaining prices.

The local union of china and stone ware manufacturers includes fifty-four important factories. At a general meeting just held to deal especially with the question of purchasing coal, stress was laid on the fact that in the period from April to November, 1901, 13,000 carloads of coal of 10 tons each had been purchased by the union and distributed among its members. Here, I should say, is a first-class chance for American coal dealers to gain a footing on the Coburg market.

One reason why our coal dealers have so far had small success in their efforts to do business with Germany is the difficulty they have had in disposing within a short time of a whole shipload of coal; but seeing that the china and stone ware manufacturers' union has within the first eight months after its formation purchased 130,000 tons of coal for its members (a consumption which will no doubt increase considerably in the future), American shippers should find it worth their while to correspond with the purchasing committee. This can be reached by addressing either Herrn Commerzienrath Swaine, Hüthensteinach, near Sonneberg S. M., Germany, or Herrn Commerzienrath Rössler, Rodach, near Coburg, Germany. I would recommend adding to the address the following: "Vorstandsmitglied der Einkaufsvereinigung von Rohstoffen der Keramischen Industrie."

Mr. Fr. Ritter, of Coburg, the largest coal merchant in the district, might also be approached on this subject with good results.

Various kinds of coal are used by china manufacturers, but preference is generally given to the Bohemian lump coal, a carload (of 10 tons) of which costs 230 marks ($54.74) at Coburg station.

Seaports to which American coal for this district could be shipped are Hamburg, Bremen, and Rotterdam.

The freight rates for carloads of 10 tons are: From Hamburg to Coburg, about 110 marks ($26.18); from Bremen to Coburg, about 103 marks ($24.51); and from Rotterdam, using the water route to Frankfort and coming from there to Coburg by rail, about 120 marks ($28.56).

American dealers must keep in mind that the manufacturers in this district have, as a rule, no arrangements for storing large quantities of coal. Most of them make, through the above-mentioned union, contracts with the pits for the delivery of a certain number of loads per week or per month.

Such convenient terms, unless a large depot were constructed at the seaport, could not be offered by American dealers; they would have to try to induce manufacturers to receive the whole supply. A very good quality, at a comparatively low price, is the inducement which may bring about this opening for American coal.—Oliver J. D. Hughes, Consul-General at Coburg.

American Furniture in Switzerland.—I give below translation of a letter I have received from Mr. Anton Waltisbühl, a large importer of American typewriters and office furniture, in answer to a communication I addressed to him in regard to the opening for American furniture in Switzerland:

"The results obtained in the sale of American desks, chairs, and bookshelves are very satisfactory. These articles are well and rationally made, useful, strong, and cheap in comparison with Swiss prices. A great drawback is the ship and railway freight, and especially the duty.

"The handling of American desks and similar furniture has been rendered somewhat difficult since the tariff has become more unfavorable. Up to the year 1900, American goods in Switzerland profited by the clause of the 'most-favored nation.' This treaty is no longer in force, as the United States abrogated it in March, 1899. At present, all goods coming from the United States have to pay duty according to the general tariff, which means an increase of 50 per cent over that paid during the time of the most-favored nation treaty. This makes a very considerable difference, the more so as the duty is paid on the gross weight.

"The following table gives a comparison between the old rates of the duty and those now in force. It is much to be regretted that a new treaty between Switzerland and the United States has not been concluded.

"Duty on furniture of ordinary wood per 100 kilogrammes (220.46 pounds) gross weight:

Description.	Most-favored nation rate.		General tariff.	
	Francs.		Francs.	
Unfinished	10	$1.94	15	$2.90
Finished	15	2.90	25	4.83
Polished	25	4.83	50	9.65
Upholstered	38	7.33	50	9.65

"Germany has the advantage of the most-favored nation clause. That country, in addition to the rates of duty, profits also by the lower freights, and it does not fail to take all possible advantage of the tariff difficulties between Switzerland and the United States. It sends with ever-increasing success German furniture made after the American pattern. I personally can not understand why the United States delays the renewal of the commercial treaty. From whatever point of view one looks at the matter, that country is the loser.

"The furniture that the Swiss are able to manufacture can hardly be imported, on account of the expense. The American import will, in my opinion, be confined to certain specialties which are made in the United States as standard articles, cheap and good, and, on the other hand, are neglected by the Swiss industry. For ordinary furniture, such as chairs, tables, beds, etc., articles of simple construction made from common kinds of wood—the American goods will hardly ever find a market in this country."

The freight rate referred to by Mr. Waltisbühl from New York to Basel is 10.50 francs ($2.02) per 100 kilogrammes (220.46 pounds).

The subject, I believe, is worthy of investigation by our manufacturers.—Henry H. Morgan, Consul at Aarau.

Cotton Fabrics and Yarns in Eastern Turkey.—There is a growing desire in the markets of Harput and the neighborhood for American cotton fabrics. Prints, calicoes, drills, sheetings, etc., of good quality should all find a steady market, as prices now rule. Much dissatisfaction is expressed at the inferior quality of the European cottonades which reach Harput.

There are several local merchants anxious to secure the representation of American houses manufacturing durable goods, and employing fast colors. I would advise such houses to send to the commercial exhibit of this consulate samples of fabrics that they have found by experience to be suited to the markets of this part of the Orient, together with agents' rates and conditions. Samples half a yard in length would be sufficient.

While the native weaving of cotton cloth is steadily diminishing, the production is still large enough to consume a considerable amount of thread. Although the culture of cotton is widespread in Anatolia, but little is spun by machinery outside of the vilayet of Adana. Local looms are supplied with yarn partly from Tarsus and partly from England. Frequent inquiries are made at this consulate as to whether American manufacturers of yarn desire to enter this market. I would be glad to receive from houses seeking to establish relations with this section agents' rates and conditions, and cards of samples. The colors should be fast and thoroughly reliable. Much disappointment has followed trials with foreign yarns, on account of the fugitive nature of the dyes employed.

Sample cards with a variety of colors should show clearly the sizes of the different numbers. Details as to the number of skeins in a package, the weight of packages, etc., should be so full that it will be easy to estimate the cost of ocean freight and of land transportation for large shipments.

This consulate will gladly facilitate in every way the entrance of our cotton products into this region.—Thomas H. Norton, Consul at Harput.

Market for Phosphates in Spain.—The trade in phosphates keeps steady pace with manufacture of fertilizers. The article is also largely employed in making dynamite and other explosives.

Up to the present, Algeria has furnished almost the entire supply from its vast deposits near the Tunisian frontier, the phosphates being shipped from the port of Bone, usually in a ground state, as, I believe, only one or two firms in Spain possess the necessary grinding plant.

Small sailing vessels bring the phosphate to this country in the two strengths of 58 to 63 per cent and 63 to 70 per cent of tribasic phosphate of lime; and as with a favorable wind these vessels can be depended on to reach a Mediterranean port in three or four days, and can be chartered at freights varying from 6 to 7 francs ($1.158 to $1.351) per ton, the advantage of the Algerian over the American phosphate in this respect is at once apparent. Manufacturers are at the same time fully alive to the value of the Florida rock phosphate, but as I understand this at present shipped in the rock only, consumers of phosphate unprovided with grinding plant are unable to use it—a fact worthy of consideration on the part of shippers from the United States.

Notwithstanding the drawbacks of distance and heavy freights, the Florida article has a certain consumption in Spain, and has given such good results in one or two instances that some manufacturers have decided to use it altogether in future.

Business in phosphates is likely to increase, and I am informed that important works are in course of construction in one of the northwest provinces, which will require a large supply of the article. Our shippers should therefore carefully study the question of freights, and if these can be reduced so as to compete with those from Algeria, America may look forward to a good share of this trade.—Julius G. Lay, Consul-General at Barcelona.

Drying Beet Pulp in Germany.—A new method of drying sugar-beet pulp which has been freed from its contents of sugar has lately appeared as a rival to the invention of the firm of Buettner & Meyer. In the latter system, which for some time has been used with success in more than a hundred German sugar factories, the pulp is dried by means of hot gases, which accompany the pulp in a parallel stream. The inventor of the new method, the owner of the machine factory of J. Sperber, in Vienna, starts with the supposition that pulp which is dried by heat from a fire must be more or less soiled by the particles of ash which come from the used-up fuel, and must, therefore, be highly injurious to the animals consuming it—a supposition entertained by many, which has, however, never been proved in practical use to be correct.

Sperber, therefore, dries with steam. The pulp is first cut up by machines into small pieces about one-tenth of an inch thick and one-tenth of an inch long, which are passed into an apparatus where they are tossed to and fro by means of shovel-like implements; afterward coming into contact with movable hollow bodies, through which steam flows. By this means, the small particles gradually lose their contents of moisture. The damp air is carried off by an exhauster which creates a small vacuum (exactly regulated by the exhauster); and this also aids in desiccating the pulp. When the process is completed, the pulp is freed from the machine by means of a screw-like contrivance and is raised up to a funnel to which sacks, for the reception of the dried pulp, are fastened.

The firm of J. Sperber has erected two specimen drying machines in Austria-Hungary, one in France, and one in Germany, the last in the sugar factory Westerhuesen, near Magdeburg. The Magdeburg machine produces about 250 kilogrammes (550 pounds) of dried pulp of an excellent quality per hour. The damp pulp, which comes from the diffuser with about 90 per cent of moisture, is pressed by a curiously constructed machine until it contains only about 3 to 5 per cent.

According to the statistics given by the director of this experimental apparatus, the amount of steam required is about 600 kilogrammes (1,320 pounds) per 100 kilogrammes (220 pounds) of dried pulp. It is hoped that it may be possible to reduce this amount; but there is a definite limit to this reduction, and it is hardly probable that Sperber's apparatus will be able to compete, on account of the working expenses, with the old method of direct drying by hot gases. Still, the Sperber system has this great advantage: It is excellent for the drying of all kinds of fruits and could also be used for meat.—Max J. Baehr, Consul at Magdeburg.

Hints for Export to Chile.—Vice-Consul-General Murphy sends from Frankfort, December 3, 1901, the following translation from the Berlin South American Outlook, December 1, 1901:

Exporters of wares to Chile should pay very close attention to the customs requirements of that country. These regulations require that every package of wares imported into Chile shall have clearly marked thereon its weight (a statement in writing is not sufficient), and the weight thus given must under no circumstances be more than 10 per cent less than that ascertained by weighing at the time of entry. If the weight is found to have been correctly given the wares are passed through the custom house with great promptness—otherwise there is apt to be much delay and inconvenience. If the weight is found to have been incorrectly stated, or if the contents of the package differ from the statements made in the customs declaration, the wares are subject to confiscation. The importer's declaration is based upon the invoice and the bill of lading. If the statements in these papers are incorrect, the customs declaration must also be incorrect; consequently, exporters cannot be too careful in preparing such documents.

American Shirt Waists in England.—Consul Marshal Halstead writes from Birmingham, December 12, 1901:

I regret to report an "I told you so" in regard to the sale of American shirt waists (blouses) for ladies in this country. A well-informed man tells me that, as I predicted in a report written eighteen months ago, the Americans did not take full advantage of their opportunity and have lost the trade. The point is that the extended credit the English shopkeeper must give, and that the jobber must in turn allow the retailer, makes it necessary for the manufacturer to do the stocking and to manage his work for repeat orders; while the American manufacturers have no use for "repeaters," and clever American shirt-waist sellers, with attractive novelties, persuaded the jobbers here, so that some of them overstocked. There has been no deterioration in the American qualities of style and novelty and in ability to sell low, but the British manufacturer is making a fairly good imitation article and is considering the needs of jobbers and retailers, which consideration the Americans will not give, my British friend jubilantly tells me.

Smokeless Powder and Dynamite in Mexico.—Consul Canada reports from Vera Cruz, December 18, 1901:

The Mexican government has granted a concession for a factory to make dynamite and other explosives in the Republic. The price of the products must have the approval of the government. The concession includes the manufacture of caps, tapers, and quick matches. The company shall also erect a factory for the manufacture of smokeless powder, of a capacity of from 176 to 220 pounds per day. Both plants must be in operation by June 30, 1903. When the company is able to supply the market, there shall be imposed an internal-revenue tax of 21 cents per kilogramme (2.2046 pounds) on all explosives imported into or manufactured in the Republic; and the government further agrees not to reduce the customs duties now in force on explosives. Common black powder may be exempted from the internal tax, provided that its components are sulphur, carbon, and nitrates of potash and soda, and not nitroglycerin, chlorate of potash, or similar substances.

Railroad Accidents in Russia.—Consul-General Holloway reports from St. Petersburg, January 10, 1902:

A recent report of the Minister of Ways and Communications shows that in 1899 there were 4,447 accidents, or an average of a little more than 12 per diem. Of this total, 1,362 were derailments, 750 collisions, and 2,335 of various other descriptions. The derailments resulted in 21 deaths and 172 cases of serious personal injury; the damages incurred by these accidents amounted to 552,862 rubles ($284,724). The collisions were responsible for 19 deaths, 238 cases of serious injury, and damage to the amount of 600,000 rubles ($309,000). Other accidents resulted in the deaths of 1,146 persons and in 2,665 cases of personal injury. Railway accidents unconnected with passenger traffic were responsible for 30 deaths and 3,860 cases of personal injury. Altogether 1,226 persons were killed and 6,933 injured.

American Flour in Germany.—There has been a decline in the exports of American flour to Europe during 1901. I am informed by flour dealers in this section that Germany has been importing the best quality of flour direct from American mills, and that this, although high in price (the duty alone being 7.30 marks per 100 kilogrammes, or $1.74 per 220 pounds), found a ready market until difficulties with the marine insurance companies arose. These now stipulate in their contracts that on shipments of flour via Amsterdam and Rotterdam claims for damage are payable only if amounting in any one shipment to 6 guilders ($2.41) on white flour and 7½ guilders ($3.01) on flour of other cereals; and on all bags damaged, an average

allowance of 12½ per cent is agreed upon for white flour and 3½ per cent for meal.

Of this change in the insurance clause, the German flour merchants were not notified and in cases of damage were great sufferers, receiving only 12½ per cent, while the actual loss was considerably higher.

American mill owners should have the matter investigated. It is also said that the railway and steamship lines charge disproportionately high freight rates for flour in comparison with wheat.

Flour dealers in this section, after having taken great pains to introduce our product, should be offered every facility to continue handling this important article.—Max Bouchsein, Consul at Barmen.

Prospects for American Coal in France.—The first cargo of United States coal ever received at Rochelle is now being unloaded at the basin of La Pallice. This is the first installment on a contract for several thousand tons, and is to be used by locomotives.

The cargo, after its long voyage, was found to be in good condition, containing, it is estimated, from 40 to 50 per cent of lumps. Accordingly, the impression made by it is very favorable. The trials of this coal, which are not yet completed, are giving splendid results and promise to be satisfactory in every way. This lot of coal was sold to the French purchasers by an important house at Cardiff, the transaction being greatly facilitated by exceptionally low freight rates.

Samples of United States coal have several times been sent to this consular district, but have always arrived in poor condition—containing about 80 per cent of dust—which has given American coal the reputation of being extremely friable. Even with this handicap, however, the coal proved to be of excellent quality.

Up to the present time, the coal supply for this region has come from Cardiff or Newcastle. On the arrival of a cargo, it is carefully assorted for the various uses to which it is intended—whether for locomotive, factory, or for domestic purposes. The dust, mixed with tar, is pressed into briquettes.

The general outlook for American coal is very encouraging. A very slight diminution of price in many instances may secure important business. The quantity annually imported into this consular district is about 700,000 tons. Of this, the proportion of anthracite is small, on account of high prices. Bituminous coal, with the highest possible per cent of carbon and the lowest per cent of volatile matter, is in great demand. Prices should not exceed 23 or 24 francs ($4.43 to $4.63) per ton c. i. f. La Rochelle.—George H. Jackson, Consul at La Rochelle.

Destruction of Fungoid Growths in Germany.—Consul-General Hughes, of Coburg, reports, December 13, 1901, as follows:

Messrs. Rosenzweig & Baumann, of Cassel, manufacture at their color works a simple and effective agent for the destruction of fungoid growths, which they have put on the market under the name of "mikrosol." Prof. Migula, of the same city, has made a thorough examination into the action and effect of mikrosol, and recommends it as very efficient, both for the destruction and prevention of fungoid growths. Mikrosol is easily soluble in water. A 2 per cent solution applied to wood by means of a brush will bring about the desired effect almost immediately. Mikrosol ought to be very useful on shipboard, especially in tropical and semi-tropical countries.

New Electric Railway in Mexico.—Consul-General Hanna, of Monterey, January 14, 1902, says it is understood that an American company has obtained a concession to build and operate an electric street-car line on several of the streets of that city, with extensions to Topo Chico, to the new steel plant, and to the smelters. It is also understood, the consul-general adds, that Mackin & Dillon, of Monterey, are the principal promoters, and that the greater part of the equipment will probably be purchased in the United States.

Small Steam Engines for Harput.—Under date of January 4, 1902, Consul Norton writes from Harput as follows:

A demand has come to this consulate for small, portable steam engines, 1 to 3 horse power. They are desired to replace hand power in several of the local industries. Wood is the only available fuel. The entire plant, boiler and engine, should be compact and easily portable. The American agency here would gladly receive correspondence and price lists for such engines and boiler outfits, with agents' rates. Communications can be sent in the care of this consulate.

Plans for Bridge Over the Neva.—Consul-General Holloway sends from St. Petersburg, January 22, 1902, plans and specifications for the new palace bridge to be built over the Neva in that city. These are filed in the Bureau of Foreign Commerce, where they can be consulted by architects. Plans, bids, etc., must be submitted by September 1 (14), 1902.

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No. 1273. February 24.—Cotton Socks and Rubber Shoes in China—Timber Trade and Government Forests in France—French Coal-Washing Apparatus—Sausages in Spain—German Enterprise in Palestine—Gas Engine Plant in Monterey.

No. 1274. February 25.—* American Furniture in Switzerland—World's Wine Crop—Prussian Income Tax—* Cotton Fabrics and Yarns in Eastern Turkey—Shoe Pegs and Shoe Peg Machinery in Eastern Turkey—* Small Steam Engines for Harput.

No. 1275. February 26. Diamond Fields of British Guiana—* Prospects for American Coal in France—* American Flour in Germany—Roubaix Conditioning House—Demonetization of Peruvian Silver Soles—Argentine-Chilean Boundary.

No. 1276. February 27.—Roads and Transport Systems in Madagascar—Electro-Magnetic Cannon in Sweden.

No. 1277. February 28.—* Market for American Billiard Tables in Austria—Electrical Progress in British Honduras—Sailing Vessels in the Suez Canal.

No. 1278. March 1.—Agriculture in Eastern Siberia—Freight Rates from Singapore—Crossing Lake Baikal in Winter—Population of Russian Cities—Coffee Crop of Salvador.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

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